The role of science notebooks in La main à la pâte*

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Abstract

The use of science notebooks as part of science instruction has been a global practice in many science classrooms for many decades. In the traditional classroom, teachers associate the use of the science notebook for recording students' work after a "recipe following" practical session in the science laboratory. However, research shows that the science notebook transcends its traditional role if it is used for purposeful recording and thoughtful reflection in a variety of learning situations that promote scientific inquiry. This article discusses the role of the science notebook within the context of La main à la pâte science education programme as an ongoing documentation of the development of children's ideas as they move through the process of scientific inquiry.

La main à la pâte

La main à la pâte (LAMAP) is an inquiry-based science education programme that was launched in France in 1996 to revitalize the way science is taught in primary schools. Based on the philosophy of social constructivism, the LAMAP programme encourages active participation in science lessons through inquiry-discovery situations and skillful questioning by teachers. Children are exposed to situations that arouse their curiosity towards natural phenomena, stimulating them to ask questions and discover the answers as they move through the process of scientific investigations. They are led to discover and learn science spontaneously and naturally, as they construct knowledge using materials and equipment familiar to them.

Children exposed to the LAMAP approach learn to appreciate the nature of science and to respect facts and people around them. As they present their ideas and listen to their classmates' point of view in science lessons, they learn to respect one another and communicate among themselves about scientific truths. Through these virtues, the spirit of constructive citizenship can be inculcated.

The Ten Principles

The LAMAP programme is structured around some basic rules, now known as the Ten Principles. The Ten Principles of LAMAP, some of which are localized for France include:

- Children observe and experiment on real object or phenomenon
- Children argue and reason, share ideas, build knowledge
- Teacher proposes activities arranged in sequences, leaving ample space for children's autonomy
- Teacher spends a minimum of 2 hours/week on the same theme for several weeks. Ensure continuity over five to six years of elementary school.

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*This article is adopted from a pedagogical document in La main à la pâte website, Cahier d'expériences contributed by Edith Saltiel, Alain Chomat and Beatrice Salviat at http://www.lamap.fr/?Page_Id=17&Action=1&Element_Id=626&DomainScienceType_Id=2

- Children fill their science notebooks with their own words
- Aim to an appropriation of scientific concepts/procedures along with language (oral and language) acquisition.
- Family and neighbourhood are closely associated
- Scientific partners accompany the work.
- The trainers of vocational schools (IUFM) are involved
- Internet resources and information exchange facilities are widely used: http://www/inrp.fr/lamap

One essential element of the ten principles is the use of the science notebooks by children to record any form of work they have performed in the science classroom, or related activities which they carry out at home. The science notebook in the LAMAP classroom is used as a documentation of children's progress in learning science all through their primary school years. This paper discusses the role of science notebooks as a means of expressing children's thoughts and experiences and how this can enhance the children's oral and written expression of words as they gain knowledge and understanding of scientific principles.

The Science Notebook in LAMAP Classroom

Ruiz-Primo, Li and Shavelson (2002) defined a science notebook as a compilation of entries (or items in a log) that provide a partial record of the instructional experiences a student had in her or his classroom for a certain period of time. The notebooks may contain description of problems the students tried to solve, procedures they used, observations made, conclusions and reflections. However, their studies revealed that writing in science notebooks was mainly mechanical and the quality of the students' communications was poor. Results were usually never organized in a way that could help students find patterns and were rarely used as evidence in conclusions. This may be associated to the traditional ways of using the science notebook with copied drawing and texts with the "right answers", in other words, a book without any errors as it is systematically corrected.

The science notebook in the LAMAP classroom is viewed as a document which is progressively completed and designed by the students during their school years. It records scientific activities done in class as an individual record or a record of work done in a group. The science notebook reflects the diversity of activities in a science class. Over the school years, the students will describe problems they tried to solve, record their discoveries, their doubts and questions by means of drawings, diagrams, photos, tables, graphs, plans, texts and practical realizations.

What do children use to record their work?

The science notebook is a way of keeping together all scientific writings that have been carried out in science classes or at home. It can come in different shapes and sizes: a folder, a book, or even a big cardboard box containing sheets of paper, posters or models created by the students. Students will write directly on their notebooks. However, with younger children who have not acquired writing skills, the teacher will help the children with the writing. The science notebook may be used to record information gathered by the students from different sources through documentary research: sheets of paper, texts written on the computer, photos, photocopies or posters.

In the LAMAP science classes, the notebook includes not only the students' personal records of their work (Personal Writings) but also collectively drafted written work resulting

from group discussions and reformulation of their conclusions (Collective Writings). Students keep two sections in their notebooks, one for Personal Writings and another for Collective Writings. Each section can be differentiated from the other by using different coloured paper or different coloured writing.

Personal Writing

In the section of the notebook for personal writing, the student uses his own words to write explicitly what he thinks and what he has understood, but not what he thinks he has understood, or what he is supposed to have seen. He is allowed to make spelling mistakes which he will correct later. Before an experiment, the student will write down his predictions on what will happen and justifying his thoughts. After an experiment, he will write a summary of what he had actually carried out, his observations and his personal conclusions or conclusions made by his group.

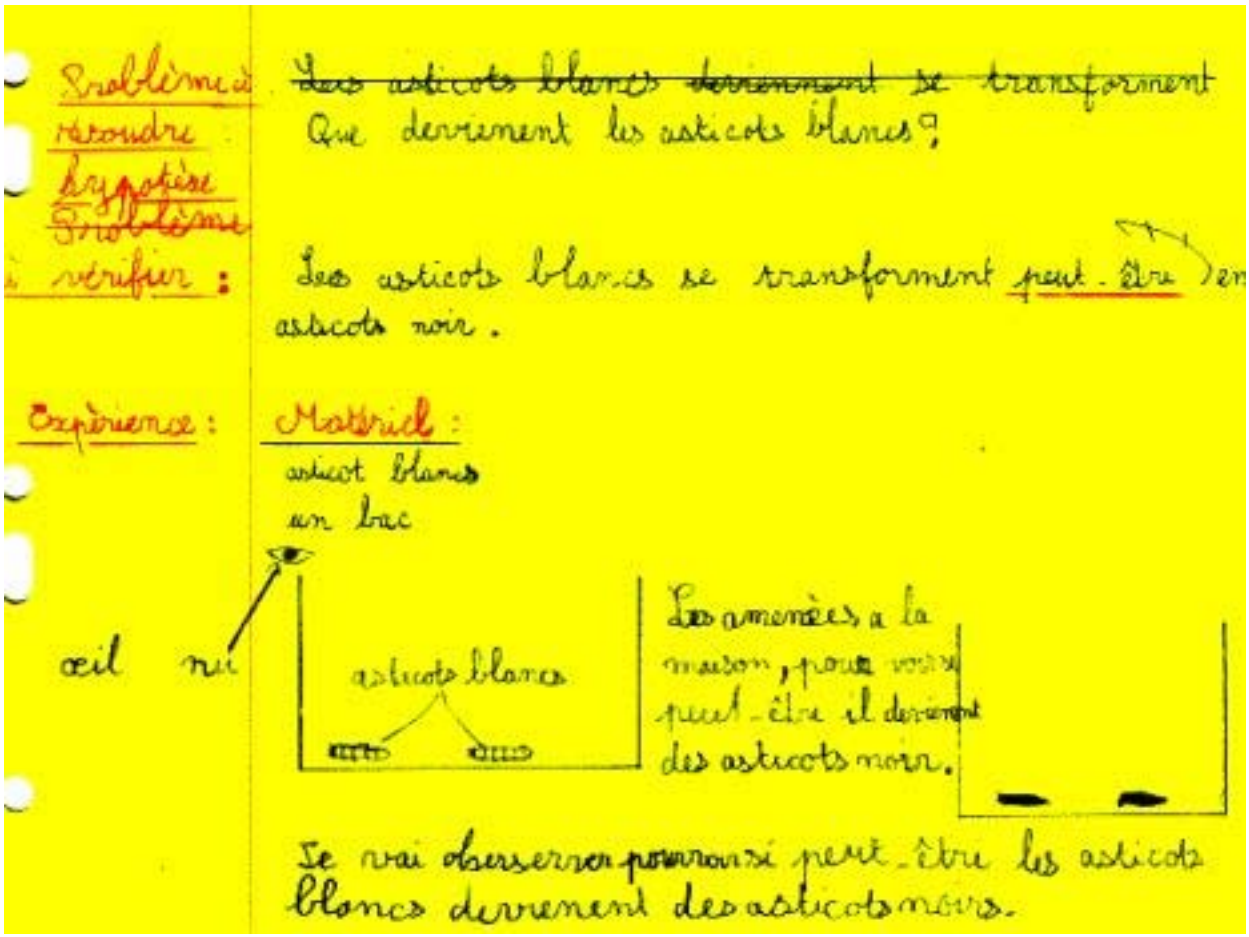

Figure 1: An example of a student's personal writing - the student's statement of problem, hypothesis and experience. The student made a hypothesis that white maggots may be transformed to black maggots. He would bring back the white maggots and observe to know if the white maggots turn black.

The following except exemplifies the significance of personal writing in the child's learning of science.

"It is important that a child uses his own words: that his knowledge is built from what he does. The science notebook is a place where the child puts down his experiences on paper so that his experiences last longer and can be read at another time, perhaps by people other than himself. By putting his experience in writing, the child is forced to elaborate on the

experience, to decentralise his point of view and to find the best words to be understood by others. But it is important that it is really his own written work, and that it is the child who writes about science with his own words, and not a very perfect summary which clashes with what he knows." (Sophie Ernst, 1997)

The Role of Personal Writing

Personal writing helps children to structure their thoughts. When they write, children question themselves on what they want to do. Having their ideas systematically recorded enables the student to recall what they have done and allows them to reflect on their observations and measurements, to analyze the chronology of past or future events, to comment critically and to compare their ideas with others.

The science notebook is the witness of the student's progress in learning and a reflection of all his trials and errors. By referring to his earlier work, the student can see his own progress and accept that learning involves making mistakes and occurs through trial and error. Personal writing serves as a starting point for the elaboration of collective knowledge.

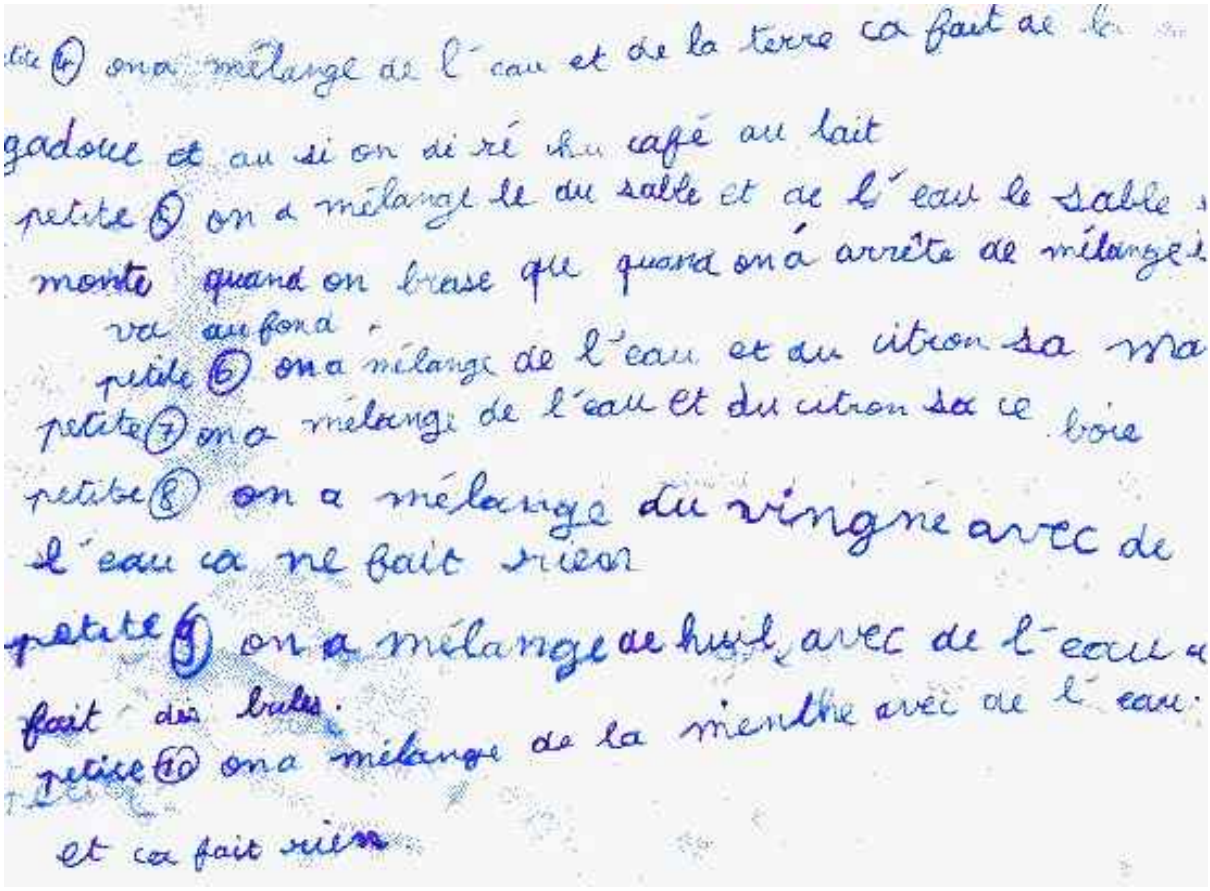

Figure 2: Individual writing helps children to structure their thinking
Translation:
4 We mixed water and soil, it became mud and it appears like coffee with milk
5 We mixed sand and water, the sand moves up when we shake and moves down when we stopped shaking
6 We mixed water and lemon and this is small
7 We mixed water and lemon and we can drink it a bit
8 We mixed vinegar with water and nothing happened
9 We mixed cooking oil with water and it makes bubbles
10 we mixed menthol syrup with water and nothing happened

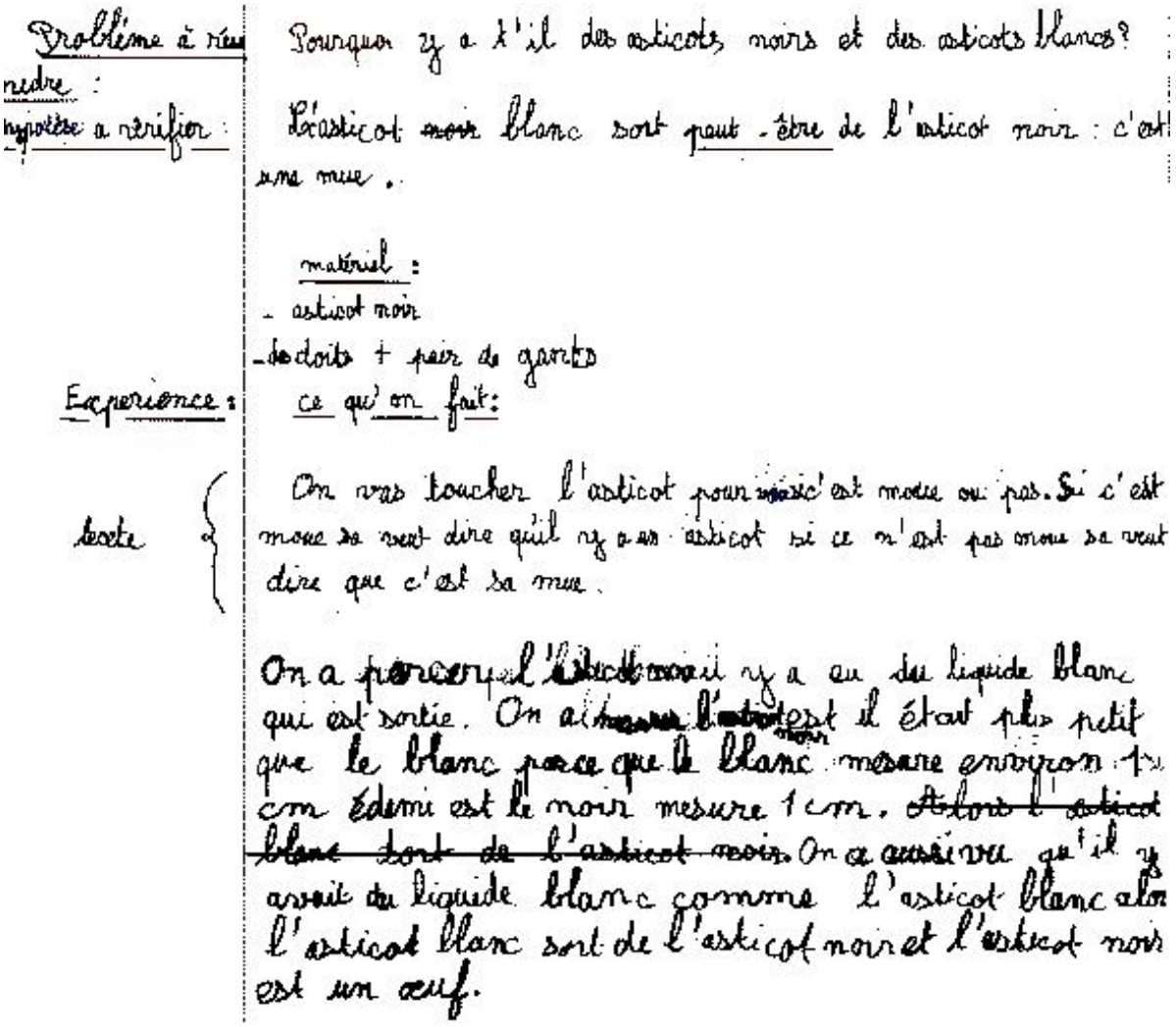

Figure 3: The science notebook reflects the child's progress.
The child was investigating why two kinds of maggots exists – black and white. He formed a hypothesis that perhaps white maggots came from the black one: its moult. He described what his group did to solve the problem.

"When children were not used to writing, they had not developed their own way to think and any debates to validate the hypothesis were weak because of this lack of written practice. The written word was not an essential objective for the students. This objective has been put in place when we see the difficulties of special needs students." (Pascal Ignace)

Collective Writing

The first type of collective writing is one that is written by a group of students. According to the themes which have been discussed, each group will write the outcome of their discussions to be shared and understood by other students in the class. This may include a summary of the class's hypothesis, a summary of the group work done together, results of discussions on the experimental procedures, observations, measurements and interpretations of the results, all of which require students to agree on the type of experiment to be undertaken and to defend their choice.

Another type of collective writing is one that is done by the whole class. Teachers can help students develop a framework for collective writing based on the following questions.

- What do we know about this subject?

- What are the problems that have to be solved?
- What did we do?
- What did we observe?
- What tentative conclusions can we draw from it?

Collective writings guided by the teacher with the class are intended to reorganize students' procedures, interpretation of data and findings and reconcile incompatibilities between the results of the various groups of students. This may be followed by the formulation of new hypothesis and planning of further investigations. Towards this end, the role of the teacher is pertinent in facilitating the children to progress from their initial conceptions (children's ideas) to the scientists' ideas. Guided by the teacher, the accumulation and synthesis of information and evidence from all group or individual investigations can be used to generate explanations, explore the theme being studied, and suggest questions for further investigations.

Collective writings done in groups or carried out by the whole class are subjected to stricter spelling rules and syntax than that of personal writing. A continuous and well-planned alternation between personal writing and collective writing develops the students' scientific writing skills as they acquaint themselves to the characteristics of the scientific language.

Using the science notebook in the classroom

At the beginning, students do not write in an automatic, spontaneous manner in their notebooks. The skills associated with writing in their science notebooks are built over the course of their schooling years. Therefore, it is important that students retain their notebooks throughout their primary school years. Their notebooks will be useful for them to find records of their own activities and progression of thoughts, to search for elements from which to build new skills, or for points of references from which ideas can be improved. The reflection of the factors that influenced their thoughts and conclusions at various points of time, and thoughtful discussion of findings and data in the context of their activities make up the essence of scientific thinking. Students should be made aware of the importance of these processes of thinking in order that they develop an appreciation for the value and necessity of expressing their ideas and interpretations when they carry out investigations.

For a start, children can be provided with a guiding structure that will help to make visible the forms of inquiry relevant to various domains of science. A structure to guide them through the process of investigation and build up the writing process may consist of questions such as: "What do I want to find out?"," What have I observed?", "What have I carried out?", "Why did I do it this way?", "What material did I use?", "What did I notice?" and "What can I conclude?" This guide can be put together as a poster in the classroom, or given as a list of questions. An example is shown in Table 1. Other teachers use sheets of paper where the questions are already written; children will gradually get used to questions linked to the scientific process and will not feel constrained by their lack of knowledge.

Table 1: *An example of an investigation guide that was given to students in the Dordogne area*

Experimental process in science	
for individual students	**for groups**
Problem	
1. What am I looking for?	What are we looking for?

Hypothesis

2. What do I think? What are we thinking?
   What do I want to do? What do we want to do?
   What do I suggest? What do we suggest?
   What do I have to check? What do we have to check?

Experiment

3. What am I doing? What are we doing?

Result of the experiment

4. What am I observing? What are we observing?
   What am I measuring? What are we measuring?

Conclusions

5. What can I say? What can we say?
   What can I take away? What can we take away?

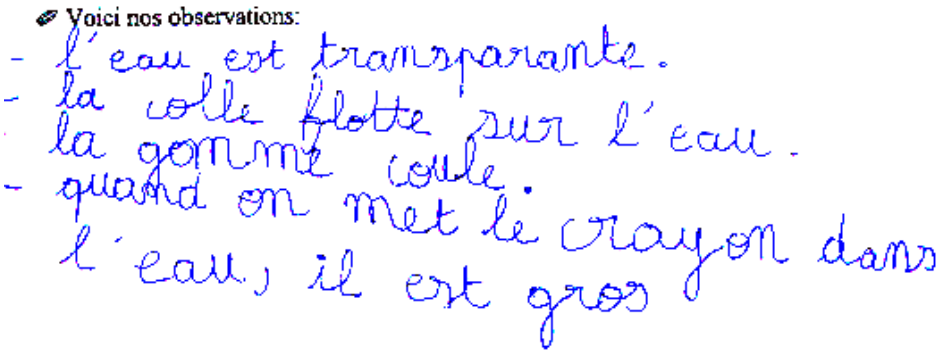

Figure 4: Students observations written in their own words
Translation:
Here are our observations

- the water is transparent
- glue floats on water
- eraser sinks
- when they put the pencil in water, it is big. (The student meant that the pencil appears bigger in the water than in the air).

At each step of the scientific investigation, it is important that the teacher encourages the students to write in their notebooks, label their drawings, indicate the date, organize their work and remind them that they must be able to read what they have written. However, students should not be forced to write if they find it very difficult to do so. In kindergarten classes, children who have not acquired writing skills draw pictures which they explain to the teacher.

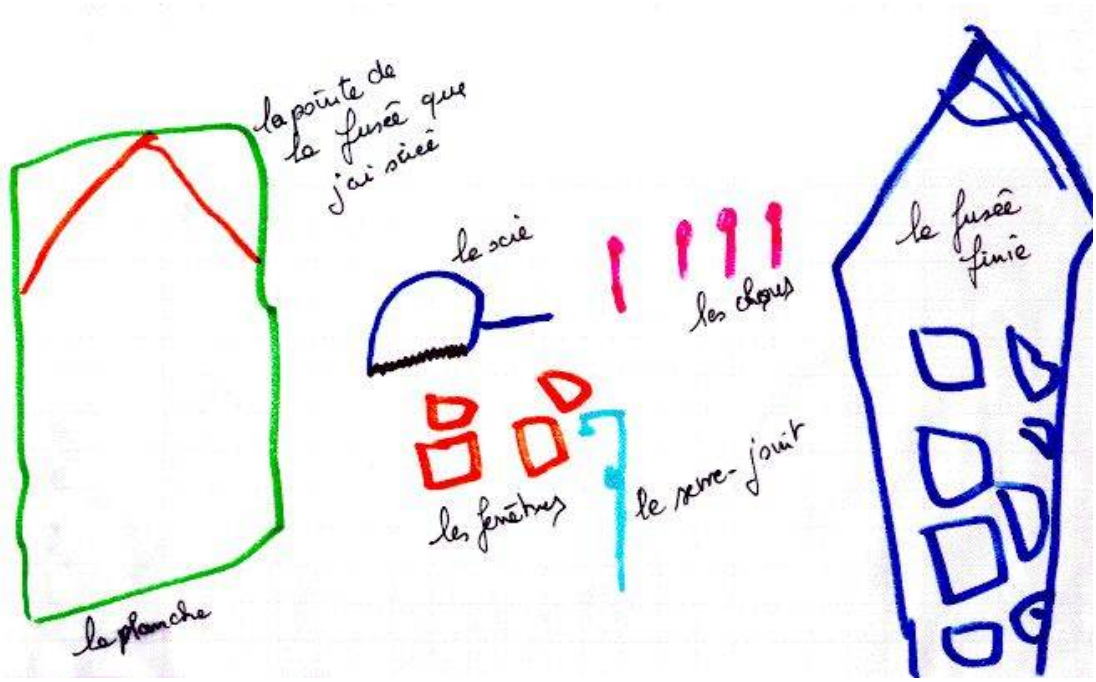

Figure 5: An example of a child's drawing illustrating his ideas on how to build a rocket.
The pictures are labeled by the teacher, but it was the child who dictated the words to the teacher.
Translation:
La planche : wood board
La pointe de la fusée que j'ai sciée : the rocket's head that I saw
La scie : the saw
Les clous : the nails
Les fenetres :the windows
Le serre-joint : handscrew
La fusée finie : the finished rocket

Development of Language Skills

When students are given the freedom to plan their investigations and compare their findings, it is possible to set up meaningful oral exchanges in the class through group presentations and whole class discussions. To this end, although language is not the primary objective in the approach that underlies the activities of LAMAP classes, the pupils gradually build up language skills, both oral and written while developing their thoughts at the same time.

Whether individually or collectively, the role of language applies when students:

- Formulate knowledge that is being constructed: to name, to label, to classify, to compare, to develop reference and to transmit;
- Establish relationships: to interpret, to reorganize and to give meaning to their data
- Assert a point of view: to convince, to argue or debate
- Interpret reference documents: to research using documents, to document or to consult

(Centre national de documentation pedagogique, 2002, pg 11)

Other than the fact that students get to learn vocabulary or acquire skills in writing summaries, personal writing can allow them to reaffirm themselves. For example, writing a

different hypothesis from other students can allow them to orally defend their point of views and contribute actively in scientific debates.

To encourage students to write about science, it is possible to assign them to write creatively about the scientific themes they study, for example to assign them to write a poem about the eclipse of the sun, or to describe the journey of a piece of bread through the human digestive system, or to imagine their lives if they were gerbils. Such entries should also be incorporated as components of the science notebook. Other types of writing related to the science curriculum such as letters written to friends about what students had investigated, or scripts for role-play on a science topic can also be considered.

Table 2 presents some pointers to teachers on measures that can be taken to improve the quality of students' written work.

Table 2: Developing Children's Writing Skills

- Self assessment: Students review and improve on their work after a collective discussion.
- Peer assessment: Students exchange notebooks with their classmates. Their classmates will check and explain what he has understood (on separate sheets of paper or "post-its") from the student's writing. Another variation is to provide the students with a check-list on the essential elements required of the investigation that was carried out and to have their peers comment on each element. This exercise can be done in pairs.
- Recording new vocabulary: Students note down new words that they learn. A new scientific word is used only if it makes sense to the student. Explanations are done using the children's words until the exact meaning is found. New vocabulary words can be recorded in a section the science notebook or kept in a separate vocabulary book.
- Comparing students' notebooks: The teacher can show other children's work to illustrate various ways in which information can be presented. This strategy can also be used to lead the students to discuss and arrive at a group decision on the best way to write or represent information when one student's work differs from another.

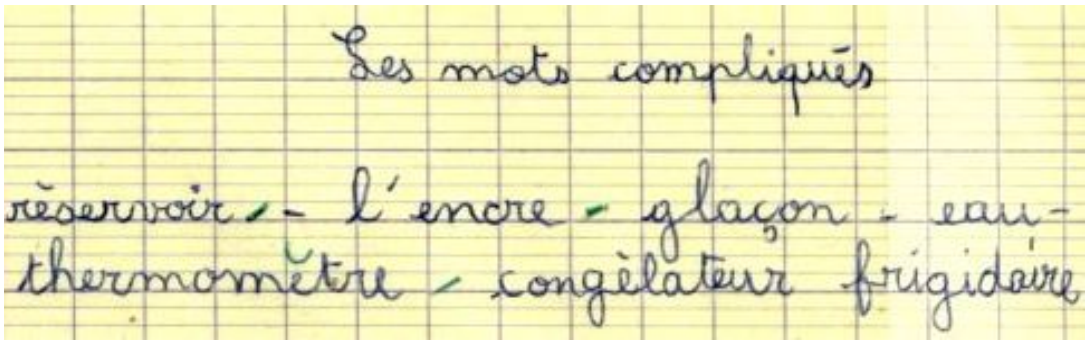

Figure 6: Example of vocabulary words at the beginning of a notebook
Translation:
Complicated words
reservoir, ink, ice cube, water, thermometer, deep-freeze, refrigerator

Implications for Teachers

Research by Baxter, Bass & Glaser (2000) found that the contents of science notebooks are dependent on teacher influence, particularly in the elementary science classrooms. Teachers need to master the fundamental conceptual knowledge to be learned by students in the unit as well as the nature of scientific processes and thinking in order to guide students learning and to make the best decisions on the type of work students should be doing and recording in the notebook. In this regard, the main website of La main a la pate (http://www.lamap.fr) was set up to support teachers by providing an extensive description of experimental activities and scientific documentations and to serve as a platform for exchange of ideas among teachers, scientists and trainers. Teachers can post their questions through the main website and obtain response within a certain period of time. This form of support is possible through the encouragement of two forms of partnerships:

1. Partnerships between teachers and pedagogical experts for advice pertaining to the pedagogical aspects of teaching and learning
2. Partnerships between teachers and scientists and/or engineers to address scientific concepts and technological problems

The two broad networks of pedagogical experts and scientists are available not only to address the questions and problems of the teachers but also to work together and to provide support in setting up experimental activities in the classroom.

Notebooks or other forms of scientific writing can facilitate teaching and learning in the science classroom if teachers take advantage of the potential of purposeful recording and thoughtful reflection about their students' experiences with science. It is also important that students realize the importance of the process of thinking and reasoning in science in order for them to develop appreciation for the value and necessity of scientific inquiry.

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