Assessment of experimental activities in France

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Plan

Introduction

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Teaching sciences in France

In France we have our own way of doing things:

- biology and geology on one side, physics and chemistry on the other side are taught by the **same** teacher
- the ratio of experimental activities practiced by pupils themselves is the most important in Europe. Some optional syllabuses (*MPI, PCL, speciality*) even present only experimental activities.

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First, our academic context will be presented. The topic will be limited to secondary education, that is to say to **junior high school** *(collège)* from eleven to fifteen years old (4 years long) and to **high school** (*lycée)* from fifteen to eighteen years old (3 years long). At the end of junior high school, there are three kinds of high schools, the general ones which lead on to University, the technological ones which lead to further technical studies and the professional ones which enable students to look for a job straight away. Just the **general** ones will be presented.

There are 180 hours dedicated to PC throughout junior high school (210 hours in BG); curriculum is based on experimental activities. Lab work is mandatory but no specific time is allocated to it. So, in fact, because of the large size of the classes and because of the shortage of scientific material, all the experiments are not done by the pupils themselves. New curriculum in 2006 will promote an investigative approach (as in primary education) as well as additional experimental activities…

In high school, for scientific general courses (S), there is about 40 % of lab work; lab work is part of the pedagogical syllabus; so in half-groups pupils actually do the experiments themselves.
More details can be found on the **poster realised by UDPPC**, the French physical and chemistry teachers' association.

Assessment of experimental activities

1. National school exams

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1.1. At the end of junior high school

Now pupils obtain the "*DNB, diplome national du brevet*" which is an equivalent to the British GCSE with :

- **three written tests** (6/20) in French, Mathematics and History-Geography. In 2007 the science test will exist as a written test; pupils must then choose between history-geography and sciences.
- **the marks** (14/20) obtained during the last two years *(4ème and 3ème)* in junior high school. Nowadays, Sciences are represented in this diploma by the assessments made during the curriculum (the coefficient is 1 out of 20 for PC and 1 out of 20 for BG). This assessment could comprise a ratio of experimental activities through lab work; this kind of assessment is not very important at the present time, but it is increasing teachers are urged to organize, for example, at every level of the curriculum, an experimental test as in *baccalauréat*. Some experimental tests are put on line in order to help teachers; their address will be given.

Assessment practices in classes will be described after explaining the experimental test of the *baccalaureat* which influences teachers' practices.

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1.2. At the end of high school:

For scientific general courses, at the end of the studies, there is an examination named *"baccalauréat"* (which is equivalent to the bachelor's degree or to the A levels in GB). This examination has consisted since 2003 in a **written test** (16 points out of 20) and an **experimental test** (4 points out of 20). *(BO n°27 du 4 juillet 2002)*
Before 2003, there was only a written test.

- the **written test**

Before 2003 the written test included a mandatory exercise based on an experimental protocol (5 points out of 20), about which there were many questions.

Since 2003, this constraint doesn't exist anymore; nevertheless most of the exercises are based on experimental situations whose protocols and experimental measurements could be devised previously and analysed afterwards; there are some questions about **the choice of materials** (What glasswork is to be chosen in a list to make a dilution? Why must you take a memory oscilloscope and not a simple one to measure this voltage ?… Some questions also about the **use of experimental equipments** (How to connect an oscilloscope in an electrical circuit? Making the scheme of the necessary equipment so as to make a titration ….). Experimental activities made by pupils themselves during their schooling help them to succeed in the written test because they are accustomed to experiments and to handling scientific material.

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- **the experimental test**

Modality

The subjects come from a national bank of 100 subjects, especially designed to make final assessments (they mustn't be used by the teacher during their sessions); 25 of them are chosen two months before the test and sent in the schools who choose among them (5 to 10); then the lab staff can prepare the test (buying products, buying material, adjusting the subjects to local needs).

After drawing their subject, pupils experiment alone during **an hour**
A teacher assesses 4 pupils; he watches them and fills in an observation sheet especially contrived for this test.

For example:
The skill "**handling a scientific equipment"** can be assessed.

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On this slide there is an example of a part of an experimental physics tests. In many subjects related to electricity pupils must **"realize an electrical circuit from a scheme"**;
A part of a subject can be seen which describes what the candidate has to do.
Here, when the candidate has finished the electrical circuit, he calls the teacher who checks what pupils has done and circles the star on the sheet if the item is validated.

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In chemistry, pupils must know how to "**use a burette"**. So at the moment of a titration the teacher is called and he watches how the candidate experiments;

-the candidate washes the burette with water, the teacher circles the star
- The candidate adjusts correctly the 0 level…
- The candidate makes a mistake because he doesn't read the meniscus at eye level, so no star
- what about the "washing with titration solution"? Two possibilities :
    - the candidate doesn't wash the burette with titration solution, so the teacher crosses out the star.
    - second possibility, the teacher hasn't been able to watch because he was busy with another candidate, so, being doubtful, he circles the star after the test…

Grading
11 to 13 points out of 20 bear on experimental skills: gestures, behaviour, safety, care, cleanliness.
7 to 9 points out of 20 bear on measuring results and on answering questions about the understanding of the experiment (for example, why the colour of permanganate disappears at the beginning of the titration?...)

The skills which can be assessed in experimental activities in secondary education are going to be describe.

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Tests (**written and experimental**) in the exams, as in school, must mandatory assess only skills which are comprised in the syllabus;
There are two kinds of skills:

- general scientific skills which are indicated at the beginning of every syllabus;
- fundamental knowledges, know-hows and specific skills which appear in the different chapters of the syllabus.

General scientific skills:

- *experimental:* making hypothesis about events which may happen, suggesting experiments, describing experiments, choosing material or explaining the why of using such and such item of material, analyzing results, comparing models and experiments….
- *handling:* recognizing and naming laboratory material, following protocols, respecting safety rules, drawing the scheme of an experimental equipment, building equipments and circuits from a scheme….
- *scientific* : identifying parameters in a phenomenon, associating models and phenomena, elaborating an argumentation, using adapted units, using scientific vocabulary, making use of a graph, constructing a graph from measurements….
- *transverse:* mathematics (using axes for algebraic measurements, vectors, mathematical functions, derivative, integral, differential, equation, statistics…), computing (using a computer to get and treat data, to research documentation, to produce a document…).

In experimental testing
Pupils are assessed about skills which can't be assessed in the written test:

- **realizing a protocol** (dilution, titration, battery construction, measurement of temperature, pH…in chemistry, measurement of frequency, of voltage….realization of electrical circuit from a scheme ….in physics, dissection, ….in biology),
- **explaining the why of using such technique or such material** ;

- **handling scientific equipments** (pipette , computer, microscope …)
- **observing** phenomena
- **interpretating observations and results**.

In BG there are also some skills which have been determined for this test. They are not the same as in PC.
Teachers use these lists to construct their sessions so that pupils get the skills required.

About this practical test
When this test was still in experimentation (before 2003) and when the national test had just begun, some teachers didn't agree with it because it is heavy to organize in labs (although we do have laboratory staff). It is true that some schools had no sufficient or proper material. Some teachers were sometimes also not convinced because they thought that the assessment was limited, that pupils could get a good mark without thinking and understanding. The French educational department chose to assess different skills than in the written test, so sometimes chemical equations and links between physical parameters are given to the students. The duration of this test is in fact too short to assess the scientific approach and to provide the real experimental challenge of solving a problem in an autonomous way; so most of the time protocols are given to the candidates.
Other exams give the possibility to assess these skills: for example in *TPE* (see later)

Conclusion
Pupils appreciate this experimental test a lot, but they must be prepared for it during their secondary schooling and not only in the course of the last year; so this has modified pedagogical practises, and also it has begun to help harmonize practices between teachers.
Teachers can also assess other skills during the cursus, as in *TPE*.

1.3. In TPE (personal research), during several months (2 hours per week), groups of pupils conduct a project in sciences, precisely in at least two fields.
Like researchers, they ask themselves a problematic question or they give themselves a problem to solve and try to answer in an autonomous way. The teacher is here to supervise and to help them in case of need.
Many skills are assessed all year long when they work, as well as in regard of their final production, and at the moment of their final oral presentation.

So if they have chosen to do experiments, it's possible to assess numerous skills in experimental activities. But laboratory are often too busy and it's not always possible to experiment during TPE. So sometimes there are very few experimental subjects who, often modest, would enable students to adopt a real researcher approach and to work on subjects who are often more easily understable…

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2. Assessments of experimental activities in classes

On account of the experimental test and of the importance of experimental situations in the written test, many experimental activities are done in the classes by the teachers or by the pupils during lab work. Many modalities for experimental activities and many kinds of assessments exist.

The most frequent modality is that, at the end of the session, the teacher collects the **proceedings** and assesses them. Often pupils are given a methodology sheet, to provide some help.
Experimental tests (like *baccalauréat*) are not frequent, without doubt because they are heavy to organize and also because classes contain about 18 pupils during lab work in high school and 20 to 30 in junior high school.
Nevertheless some solutions can be suggested:

- the teacher can be helped by another teacher.
- the teacher can assess one part of the class while the other part is working on another subject.
- the teacher assesses very few skills, or just few pupils during the session…the others will be assessed during an other session.
- Pupils can practise self-assessment. Pupils have worksheets for handling correctly the material…
- During a written test, pupils come one after the other (or 2 by 2) to the teacher's desk and realize an experiment or handle a scientific equipment…

These kinds of assessments are increasing at every level; many examples are available on Internet (modalities and subjects):

- Junior high school
  http://www.ac -creteil.fr/physique/html/niveaux/college/capacites_experimentales_college.htm.
- High school
  http://www.ac-orleans-tours.fr/physique/default.htm#

Seldom there is an assessment of a **scientific approach** in which a pupil has to suggest a protocol and realize it by him or herself. Anyway, ready-made simple tests are available on the net and could be used for that purpose.

In written tests, teachers are urged to choose exercises about experimental activities done in classes or very close to these; lab work is part of the progression of the courses…

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3. Assessments in national competitive examinations

I would like to tell you about two national examinations which assess experimental activities:

3.1. The national Olympiads of Physics

This examination was initiated by UDPPC and SFP. It looks like TPE; groups of pupils conduct, during several months, an experimental project, simple or complex, often open onto other fields.
They solve, with experiments, some questions such as:

- Is it possible to break a glass while you are singing, like the CASTAFIORE does?
- How does sap climb at the top of trees?
- Why the butterfly's wings have so nice colours ?....

The jury assesses several skills and qualities, specifically those about experimental activities. So, experimentation quality and scientific approach take a great place in the assessment.

3.2. The national Olympiad of chemistry

In this examination initiated by UIC, there is a long experimental test (6 hours) with synthesis and analyze. As in the experimental test of the *baccalauréat*, pupils follow a protocol and are assessed; half on handling skills and half on their understanding of the protocol. Still, in this experimental test, most relations and equations must be found out by the pupils.

Conclusion

Experimental activities take a great place in our scientific education; therefore assessments of these activities take more and more places in exams, competitive examinations and even in classes.
Nevertheless in classes, diversification in assessment and specifically assessment of experimental activities should be done more systematically every year in secondary schools.
But assessing experimental activities does not mean assessing what has been learnt through experimental activities; that is quite another matter.
Assessing experimental activities means assessing several skills which are put into practise during these activities. These skills are important from a scientific point of view but they also help build the notion of citizenship. It could be also interesting to help pupils to choose