TEACHING MATHEMATICS IN A FOREIGN LANGUAGE[*]

Preliminary note

This progressive work-document should simplify reflection about teaching mathematics in a foreign language, especially in the schools' European departments. It aims at harmonizing practices concerning the recruitment of teachers, teaching and evaluating, in this particular field, according to the official instructions. It was written in collaboration with mathematics and language Inspectors, and approved by language and mathematics think tanks of the National Education's general inspection.

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I. WHY MATHEMATICS TOO?

Opening European or oriental languages departments aims at reinforcing the pupils' language competences through using the foreign language to learn other subjects and getting acquainted with the culture of the countries in which this language is spoken. The choice of mathematics as a non linguistic subject deserves to be encouraged.

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[*] Translation, by B. Martucci, from French into English of the first part of a document retrieved from http://perso.orange.fr/jacques.moisan/DNL_math.pdf on 16/3/2007.

1) For language

Mathematics serve language

- language becomes a useful communication means and cannot be seen as a mere subject of school learning: Pupils become aware that in other countries everything is done in English, in German, in Spanish, etc… , that means that learning a language is not a school exercise, but the true reflection of reality;
- the universal feature of mathematics allows studying a great variety of subjects: history (for example, mathematics in Antiquity), economy (data processing, statistics), probabilities and their use (in biology, medicine, etc…), architecture (for instance, the golden number), astronomy, new technologies, etc.;
- Maths special words or expressions are very few and easy to understand: a useful work with the language teacher about particular points (syntax, grammar) can be set up;
- solving problems makes exchanges and discussion easier, exposure to the language is longer;
- if the contents are well chosen (not too theoretical and not too technical), a great deal of time can be devoted to developing comprehension, to oral and written production in the foreign language
- linguistic functions and specific notions (cause, consequence, etc) are meaningful because they are used in the right situation. Lots of examples to choose from: reading figures and numbers, expressing inferiority and superiority, comparatives and superlatives, reasoning and argumentation, necessary conditions " we must…", sufficient conditions "we only have to…" question-sentences and use of composed question-tags as *how deep*, *how often*, *wie oft*, etc…, telling hypotheses " it seems…", using sentences with " if…, then…", using complete sentences with link words: if, as, since, therefore, *da*, *deshalb*, etc…), describing geometrical objects, the instructions about geometrical constructions, etc.
- these linguistic functions allow imparting a concrete and useful language.

2) For mathematics

Language serves Mathematics

- the pupils' attention at mathematics is bigger for example when they read or write texts in a foreign language or when the content isn't attractive any more because it has already been studied in prior levels (for instance in" second" affine functions). The necessary comprehension of the notions allows pupils to make progress (study of logical schemas by reading a text or a subject explanation);
- working with mathematical notions in another context, especially in a linguistic context with methods which are specific of a country, allows to understand different points of view (examples: in Anglo-Saxon countries fractions are systematically discomposed as the addition of a whole and of a fraction inferior to one, in Germany the classification of quadrilateral is made according to the number of the elements you need to construct them, but in France they are classified according to the number of properties of "the squared parallelogram";

- the colourful and immediately understandable feature of some mathematical terms gives more sense to the objects they describe and you often find the definition in the word itself (examples: in German "Durchmesser" for diameter, or "Hochwert" for "ordered" ; in English "common difference" (*raison d'une suite arithmétique)* or "a one-to-one function" (*bijection)*;
- the practical feature of many terms makes their learning easier; in English for example "x-axis" (*axe des abscisses)*, you also find technical terms which are very similar to those used in French "diameter", "quadrilateral", "numerator", etc.;
- machine language is easier to learn on the keyboard (example: Ans), with instructions (examples: Data, Range, Row), by programming (example: Go To);
- pupils who are better at foreign languages than at mathematics will feel valorised and will gain more confidence; moreover, as difficulties and requirements are not technically as important as in a standard mathematics course, the pupils will feel a new motivation for the subject;
- the teacher who prepares his "double" course pays more attention to the educational method he uses in class in order to make the purpose of the problem clear, to asking questions in another way, to creating a class discussion, and to suggesting regular recap times. When switching from one language to the other, the teacher simplifies his explanation, avoids digressions: the course becomes more efficient, more refined.

3) For culture

- concrete problems are chosen in the partner's language books and thus, contribute to discovering cultural situations of life: for instance, well chosen exercises about proportionality, percents, statistics or probabilities refer to the cultural background which is specific of the concerned country (measure units, money etc.);
- studying scientific texts in the foreign language, biographies of foreign mathematicians, visiting museums or exhibitions enrich the scientific culture of the pupil;
- this different approach which reveals different mental processes contributes to opening the world's perception.

4) For the school and professional training

At times when the mobility of students (training and training courses abroad, exchanges) is becoming current, having been taught mathematics in a foreign language gives you a true plus-value if you study sciences.

II. PROFILE AND RECRUITMENT OF A BILINGUAL MATHEMATICS TEACHER

We want to give here the profile of a teacher who is able to teach in the European or bilingual departments and to explain the specific aims of initial or further training

A. GENERAL PROFILE

The prerequisites to teach a non- linguistic subject (*DNL[*]*) are as follows:

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[*] DNL, French acronym for *discipline non linguistiques*

1) Educational competences in the subject

The teacher must master didactics and teaching -pedagogy in France, in particular he must be able to teach according to the official instructions.

2) Knowledge of the foreign language

Three levels of mastery of the foreign language are required:
* a good fluent mastery of the current language in order to communicate with the pupils and to create a linguistic atmosphere, to express simple and practical situations in the partner's language; his language must be fluent enough to make him able to react in the foreign language in unexpected situations;
* mastery of the specific subject's wording;
* the usual classroom language which must be only in the foreign language;
* besides, it would be very helpful that the teacher know the guiding principles of didactics and teaching- pedagogy of foreign languages in France.

3) Knowledge of the two cultures

In reference to the subject he must be able to explain the different concepts, their possibly divergent connotations, to recognize the cultural background of the content under study. It also seems important to know about the differences between didactic approaches in the concerned countries.

4) Linguistic managing of the class

The "DNL"- teacher has to show real qualities for managing a class
* he encourages the pupils to talk, to use current language, he creates a linguistic atmosphere, progressively brings in new idioms, maintains prior knowledge alive;
* he gives priority to comprehension, to reflection and to production without having too strict immediate linguistic requirements: he avoids stopping fundamental reflection; he allows for phases of preparatory work (for example loud reading of instructions will be done after a silent reading). The main thing is to teach the pupil how to express himself and to make himself understood, without failing however, to give back the correct form;
* he is aware that the comprehension skill in a language is always superior to the production skill. He knows how to distinguish the active vocabulary from the passive one.

5) Team work

Because bilingual teaching is integrated into an educational project which is also part of a school project, the "DNL"- teacher is open to discussion and ready to work in collaboration with other partners of the team.
Partner- working with the language teacher is especially necessary as much in the field of language pedagogy as in the field of the pupils' knowledge and for the evaluation of their work.
We also must ensure the continuity with the upper classes and plan the taking over of the teacher.

6). Use and production of documents

The "DNL"- teacher can't only refer to the textbook. He often must make documents in the foreign language with the help of a bibliography or websites for himself and for his pupils, he will clarify, simplify and adapt. He is also open to new technologies of communication and teaching.

7) Pupils' evaluation

In collaboration with the language teacher the "DNL"- teacher must know how to appreciate, evaluate the oral and written comprehension competences, the quality of the pupils' oral or written productions by taking into account their practice and learning level in the language. We must take into account to and improve fields of the language, like pronunciation, respect of well-forming code, insofar as they contribute to the comprehension and coherence of the written and oral wording which are produced by the pupils.
The written appreciation and the mark (if any) should be written down at a special place of the school report and report-book (the remark could refer to the language standard and the mark to the mathematics standard). But the evaluation must also increase the pupils' efforts and the progresses they make thanks to this teaching in a foreign language.

8) Exchanges and cultural stays

The "DNL"- teacher is highly encouraged to maintain his own training by taking part in school exchanges with the pupils, or by attending training courses abroad.

B. SPECIFIC PROFILE TO TEACH MATHEMATICS

1) Pedagogical adaptation

- As a general rule, the teacher shows open-mindedness in relation to the requirements of teaching a non-linguistic subject and to its aims;
- he selects the contents which are suitable for teaching in a foreign language, and spots the chapter parts or the chapters it is better to handle in French;
- he is aware of the simultaneous difficulties in mathematics and in the language, he divides them up (regular and progressive timetable);
- as a general rule, he doesn't tackle a new notion directly in the foreign language, especially if it is fundamental or even particular;
- he takes into account through his teaching the pupils' different standards in mathematics and in the foreign language;
- he takes into account the fact that pupils come from different classes and have different optional subjects, he knows the mathematics program of each class.

2) Relevance of themes and supports

- the teacher must choose mathematical contents which stimulate the use of the foreign language, cultural and linguistic exchange in the class;
- he can elaborate pedagogical and didactic tools with the pupils (posters, vocabulary-book, figures with comments in the foreign language, etc.);

- whenever it is possible, he takes advantage of the concrete or plastic feature of the language in order to ensure a better comprehension of mathematical terms (in German: *Mittelsenrecht*e or *Seitenhalbierende* for a median; in English: to remove the brackets, turning point);
- he makes a critical analysis of the textbooks of the foreign country in order to pick out mathematical material in the vein of the French programs;
- he uses relevant information media (extracts from tapes, video-tapes, internet, mathematics-software in a foreign language).

3) Work with the linguist

Persuading the language teacher that it is interesting to do mathematics in a foreign language is a very important asset.

The "DNL" naturally takes his place in the field of interdisciplinarity to the advantage of both subjects. The "DNL"- teacher works with the language teacher in order:

- to prepare and extend some mathematics courses, to talk about language functions which are peculiar to mathematics (for example: "if…, then…", etc.);
- to improve through practice, and with common aims, the pupils' linguistic standard, among other things: work with grammatical phrases (for example, for a passive phrase: points mark out a figure, the figure is marked out by points), work with questions (for example: why? how? what for?, etc.);
- set up if any, coherent and common evaluations (especially if it is an oral work).

The work in common can also come true through reciprocal visits during the courses.

Finally the mathematics teacher must impart his pleasure to practice the foreign language by doing mathematics.

He has understood that this experience is foremost for the pupil not an additional load but a trump for his training, in mathematics as well as in the foreign language.