Niveaux de référence pour l'enseignement des mathématiques en Europe

Reference levels in School Mathematics Education in Europe

EMS

European Mathematical Society

http://www.emis.de/

Committee on Mathematics Education

National Presentation

BELGIUM

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Mars 2000

1. General description of the mathematics teaching context

1.1. Description of the country school system

The Belgian Constitution (art. 24) secures freedom of teaching. This means that any kind of teaching institution is authorized to write out a curriculum, and that the acceptance of this curriculum by the government is a necessary condition for the receiving grants. Belgium is a federal state composed of three linguistic communities : the Flemish Community, the French Community and the (smaller) German Community. Each Community is responsible for its teaching system.

Full-time compulsory education ends at the age of 18 years.

The majority of schools are gathered into some great teaching networks (*réseau d'enseignement*) in each linguistic community : an official network, a network of provinces and/or municipalities, a so called free network consisting of the catholic schools, and so on. All these networks are subsidized by their own linguistic community.

In what follows, we limit ourselves to the two most numerous communities : the Flemish and the French.

The secondary education divides up into three degrees of 2 years each, and is differentiated in

- the general and technological humanities, preparing to higher studies,
- the technical and vocational (professionnal) humanities, aiming at an access to the employment market at the age of 18.

In the present organization, there are various centralized systems for examining the conformity of teaching with the curricula under way (ratification - or homologation - committee, inspectorship, ...). But there is no centralized examination (analoguous to the french *baccalauréat*) at the end of compulsory school. The school alone issues the final certificate.

1.2. Place and importance of the mathematics in the curriculum

The mathematics curriculum is generally written out by pedagogical experts and/or by teachers appointed to this work by their own teaching network.

In general and technological humanities (age 12-16), mathematics are teached during 4 or 5 periods each week during the 4 years (1 period = 50 minutes), on a total of 28 to 32 (occasionally 34) periods a week.

For technical and vocational (professionnal) humanities (age 12-16), the situation is more variable :

- in the first degree (age 12-14), mathematics are teached during 3 or 4 periods on a total of 28 to 32 (occasionally 34) periods a week,
- in the second degree (age 14-16), mathematics are teached from 0 (in the French Community) or 2 (in the Flemish Community) up to 5 periods on a total of 28 to 36 periods a week.

From a more documentary viewpoint, the volume of mathematics in the third degree (age 16-18) is subordinated to various choices by the pupils of more specialized topics. In the case of general and technological humanities, it may involve 2, 4, 6 or even 8 periods on a total of 28 to 34 periods in a week. For technical and vocational humanities, it may involve from 0 to 5 periods on a total of 28 to 36 periods in a week.

2. Main mathematics objectives

The teaching of mathematics in Belgium is at present the subject of some great and mixed reforms concerning the curriculum and the general objectives of teaching.

More precisely, in the French Community a general reform of the mathematics curriculum began more than 10 years ago, and ended in june 1999. But as the writing and bringing in effect of this new curriculum came to an end, a much more general reform, directed at the secondary school in general, was superimposed to the mathematics reform. Since 1998, some new laws have been voted by the parliament of the French Community :

- the « decree defining the priority missions for primary and secondary teaching and organizing the suitable structures for that » (*décret organisant les missions prioritaires de l'enseignement fondamental et de l'enseignement secondaire et organisant les structures propres à les atteindre*),
- the « reference levels » (*socles de compétences*) describing the levels to be reached at the end of the first degree of the secondary school (at the age of 14),
- the « finality levels for the general and technological humanities» (*compétences terminales pour les humanités générales et technologiques*) describing the levels to be reached at the end of the third degree of the general and technological humanities (at the age of 18).

From now on, any curriculum has to be written out in harmony with those new laws, so that the present « new » curriculum is called « provisional » too. The curricula are in the course of adaptation in each teaching network. The whole reform has to take effect at September 1st , 2001 and must undergo a first external evaluation at September 1st, 2003.

In the Flemish Community, a similar set of reforms is in progress : reference levels for the first degree have been voted and those for the second degree are ready to be too.

The bringing into application of those reforms does not make it easy to realize a reliable report on the present situation of teaching mathematics in Belgium. Nevertheless, and in the present state of the reform, the main mathematics objectives may be extracted from the « provisional » curricula and from a synthesis of the various « reference levels » and « finality levels ».

The main innovation in all these texts is the clearly stated will to organize the teaching of mathematics around realistic problem solving and applications of mathematics, with all the concrete pedagogical consequences which result from this option. Some differences are made between transversal abilities (*compétences transversales*) - which are not necessarily of a mathematical nature - and disciplinary attainments (*compétences disciplinaires*) - which are more specifically mathematically oriented. Four basic transversal abilities may be listed :

- to analyse and understand a (mathematical) situation,
- to handle, to solve, to reason and to argue,
- to apply and generalize, to structure and synthesize,
- to communicate.

The main disciplinary attainments are gathered into some basic topics :

- numbers, magnitudes and algebra,
- solids and figures, geometry and trigonometry,
- functions,
- data processing.

3. Basic contents

The basic contents are summarized in the following tables. There are some significant differences between the two linguistic communities in geometry and trigonometry and numbers, algebra and functions, but not so many in data processing. This may help to legitimate that the corresponding tables have to be distinguished in what follows.

Geometry and Trigonometry (Flemish Com.)	General secondary education.	Technical education ('strong')	Technical education ('weak')
Elementary transformations	Translation, reflection, rotation, parallel , projection, homothetic figures, invariants in transformations, symmetry in plane figures.	Translation, reflection, rotation, parallel , projection, homothetic figures, invariants in ransformations, symmetry in plane figures.	Translation, reflection, rotation, enlargement (reduction). Properties without proof
Pythagorean Theorem	Proof. Irrational numbers.	Proof. Irrational numbers.	Without proof. Irrational numbers.
Thales	Proof. Relation to similarity	Proof. Relation to similarity.	
Similarity and congruency, plane figures	Relationship between similarity and scale. Characteristics of similarity and congruency of triangles. Properties related to angles and sides of triangles and rectangles.	Relationship between similarity and scale. Characteristics of similarity and congruency of triangles. Properties related to angles and sides of triangles and rectangles.	Relationship between similarity and scale, characteristics of similarity and congruency of triangles. Properties related to angles and sides of triangles and rectangles
Loci	Perpendicular bisector, bisector of an angle, circle.	Perpendicular bisector, bisector of an angle, circle.	Perpendicular bisector, bisector of an angle, circle.
Trigonometry	In rectangular and arbitrary triangles, trigonometric circle, complementary and supplemetary angles.	In rectangular and arbitrary riangles, trigonometric circle, complementary and supplemetary angles.	Rectangular triangles.
Analytic geometry	Coordinates, equation of a straight line, circle, distance (Extension : vector algebra (without the scalar product)).	Coordinates, equation of a straight line, circle, distance (Extension : vector algebra (without the scalar product)).	Coordinates.
Space geometry	Plane representations, (parallel perspective), relative position of straight lines and planes in concrete situations, properties.	Plane representations, (parallel perspective), relative position of straight lines and planes in concrete situations, properties.	Plane representations. Area and volume of three-dimensional figures.

Remark: enough time should be given to the solution of geometric problems.

Geometry and trigonometry (French Com.)	General and technological humanities	Technical humanities	Vocational (professionnal) humanities
Elementary transformations	Symmetry, translation, rotation, parallel projection, enlargement, reduction. Fixed point, invariant line.	Symmetry, translation, rotation, parallel projection, enlargement, reduction.	Symmetry, translation.
Pythagorean theorem	Proof. Irrational numbers.	Without proof.	Angles. Plane figures (square, rectangle, tri-angle, circle). *(Pythagorean Theorem : optional !)*
Thales	Proofs.	Without proof.	
Triangle geometry	Congruency, similarity conditions.	Congruency, similarity conditions.	
Geometric loci	Perpendicular bisector (mediator), bisector, inscribed angle, circle, parabola.	Perpendicular bisector (mediator), bisector, inscribed angle, circle.	
Trigonometry	Trigonometry in a rectangular triangle. Trigonometry in a circle, associated angles (complementary, supplementary, …). Arbitrary triangle.	Trigonometry in a rectangular triangle. Trigonometry in a circle, associated angles (complementary, supplementary, …). Arbitrary triangle.	*(Trigonometry in a rectangular triangle : optional !)*
Vector calculus	Vector calculus in the plane (without scalar product).	Vector calculus in the plane (without scalar product).	
Space geometry	Representations, parallel projection. Incidence, parallelisms. Proofs of parallelism conditions.	Ordinary solids. Areas, volumes, …	Ordinary solids. Areas, volumes, …

Numbers, algebra and functions (Flemish Com.)	General secondary education	Technical education (‘strong’)	Techniscal education (‘weak’)
Natural numbers and integers	Calculations, rules for operations, divisibility, LCM, HCF.	Calculations, rules for operations, divisibility, LCM, HCF.	Calculations, rules for operations, divisibility, LCM, HCF.
Fractions and rational numbers	Calculations, rules for operations, proportions.	Calculations, rules for operations, proportions.	Calculations, rules for operations, proportions.
Calculations	Powers, calculator, estimations, calculations with square roots.	Powers, calculator, estimations, calculations with square roots.	Powers, calculator, estimations.
Operations with letter symbols	Exceptional products, simple factorization.	Exceptional products, simple factorization.	Exceptional products, simple factorization, polynomials.
Sequences	Finite geometric and arithmetic sequences.	Finite geometric and arithmetic sequences.	*Optional !*
Standard functions and basic concepts	Situation, table, graph, formula. Basic functions : $f(x) = ax, ax + b, x^2, \sqrt{x}, \frac{1}{x}, x^3, \sqrt[3]{x}$ Transformations of the graphs.	Situation, table, graph, formula. Basic functions $f(x) = ax, ax + b, x^2, \sqrt{x}, \frac{1}{x}, x^3, \sqrt[3]{x}$, $\sin x$. Transformations of the graphs.	Situation, table, graph, formula. Basic functions $f(x) = ax, ax + b, x^2, \sqrt{x}, \frac{1}{x}$
Linear functions	Linear functions, equations, inequalities, systems of equations, applications.	Linear functions, equations, inequalities, systems of equations, applications.	Linear functions, equations, inequalities, systems of equations, applications.
Quadratic functions	Quadratic functions, equations, inequalities, applications	Quadratic functions, equations, inequalities, applications.	
Trigonometric functions		$f(x) = a \sin b(x - c) + d$, graph, equations, applications.	

Numbers, algebra and functions (French Com.)	General and technological humanities	Technical humanities	Vocational (professionnal) humanities
Natural numbers, integers	Computation rules. Divisibility, HCF, LCM. Proofs with letters.	Computation rules. Divisibility, HCF, LCM.	Computation rules.
Fractions, rational numbers	Computation rules, proportions. Approximations.	Computation rules, proportions. Approximations.	Computation rules, proportions, % , rule of three, decimal numbers.
Numerical calculus, algebraic expressions, polynomials	Computation rules, identities. Factorization. Division by $x-a$. Undeterminate coefficients.	Computation rules, identities. Factorization. Division by $x-a$.	Expressions with letters : computations, transformation of formulas.
Reference functions	Tables, graphs, formulas. Basic functions : $f(x)=ax$, $ax+b$, ax^2 , $\sqrt{x}$, $\frac{a}{x}$, $\sqrt[3]{x}$, $\lvert x \rvert$, $\sin x$, $\cos x$. Transformations of graphs.	Tables, graphs, formulas.	
The first degree	Linear and affine function. Equation, systems of equations, inequalities. Various problems.	Linear and affine function. Equation, systems of equations, inequalities. Various problems.	
The second degree	Quadratic function. Equation, inequalities. Various problems.	Quadratic function. Equation, inequalities. Various problems.	

Data processing (French & Flemish Com.)	General and technological humanities	Technical humanities	Vocational (professionnal) humanities
Tables and graphical presentations	Tables, grouping of data, bar diagram, pie chart, histogram.	Tables, grouping of data, bar diagram, pie chart, histogram.	Tables, schemata and diagrams
Middle values	Average, median, quartiles and interpretation.	*Average, median, quartiles and interpretation.	*Average, median, quartiles and interpretation
Distribution measurements	Variance, standard deviation, interquartile range (box-plot).	*Variance, standard deviation, interquartile range (box-plot).	
Calculation problems	Tree diagram (and Venn diagram).		
Probability and relative frequency	Relationship between probability and relative frequency. Easy probability experiments (tree diagram).		

* : **not** in the French Community !

4. <u>Exemplary topics</u>

The following descriptions relate to general and technological humanities only.

4.1. Quadratic equations

According to the curriculum, the graphs of the quadratic functions are derived from those of $f(x) = x^2$ or $f(x) = -x^2$ by using various geometric transformations and the resolution formula for the corresponding general equation may be deduced from this graphical study. This graph is associated to a parabola, defined as the locus of points in the plane at an equal distance from of a fixed point (the focus) and a given line (the directrix). The formulas for product and sum of the roots of a quadratic equation are proved, and used for instance as a way to verify some computations. The curriculum insists on the study of (practical) problems in physics, economy and geometry (eventually involving parameters). This topic is a very classical one, except perhaps for the derivation of the formula for the roots from the graphic study of the quadratic function.

The teachers are generally satisfied by the way their pupils overcome the subject. But we at present have no assessment result about this topic on the national level.

4.2. Pythagorean Theorem

According to the curriculum, this theorem has to be « discovered », stated and proved. It has to be used in various geometrical problems of construction, computation, research about some properties and proofs. This theorem must be used to introduce irrational numbers - restricted here to square roots of positive numbers - : approximate values, computation rules (product, quotient), and so on.

It is generally acknowledged that the Pythagorean Theorem is correctly assimilated by the pupils, even if its practical availability during a problem solving activity is not as good as hoped. But once more, we don't have any assessment result about this topic on the national level.

4.3. Similarity

In the new curriculum, the exhaustive study of plane transformations has been replaced by the study of the effect of some transformations on some geometric configurations. In this direction, the study of similarity becomes the study of the similarity conditions for some plane figures. The « discovering » and statement (but not the proof !) of the so called Thales configuration are at the heart of this study ; the similarity conditions for triangles are another significant facet of this topic. Once again, these results have to be practised in a lot of geometrical problems of construction, computation, research about some properties and proofs. Numbers are here important too, for instance in the question about the fourth proportional.

The Thales configuration and similarity properties seem not known as well as the Pythagorean Theorem, but once again, we have no assessment result about this topic on the national level.

4.4. Word problems

There is no particular emphasis on the resolution of word problems in the present curriculum, which includes two entries about :

- the resolution of problems wherein a (system of) first degree equation(s) appears,
- the resolution of problems leading to a quadratic equation.

On the other side, there is a deep insistence since the beginning of the secondary school (age 12) on the elaboration and interpretation of algebraic expressions, formulas, functions, ... by the pupils themselves in a lot of situations, concrete (daily life) or more technical (arithmetic, geometry, data processing, algebra, ...)

We have some (fragmentary) indications about the way pupils master this topic, thanks to a recent test made on a representative sample of pupils in the French Community (cfr. [11] in the bibliography). The mean score for the only question involving a word problem is 46/100, and the mean score for the question involving the construction of elementary algebraic expressions is 75/100.

4.5. Percentages

In the former curriculum, the study of percentages had to be achieved in the primary school. The new provisional curriculum for the first degree (age 12-14) intends to remedy the observed weaknesses of the pupils on this topic, by coming back explicitly on it.

Some indications are available too about the way pupils master percentages (cfr. [11] in the bibliography). In this test, the mean scores for the questions about percentages are varying from 54/100 to 68/100, and when the same questions are asked at the age of 12 or at the age of 14, the improvement in the mean score climbs from 7/100 to 17/100.

4.6. A new topic at the age 12-16 : space geometry

One of the characteristic features of the new curriculum is the development of activities around space geometry since the beginning of secondary school. At the first degree (age 12-14), these activities are about

- plane representation of spatial figures : shadow under the sun as model of parallel projection and the corresponding style of drawings, analysis of photographs, reading of (architectural) designs, unfolding of solids, ...
- some basic computations about magnitudes, problem solving, ...

In the second degree (age 14-16), the computation activities in space geometry are derived from plane geometry, for instance :

- the Pythagorean Theorem allows the computation of the length of the main diagonal of a (right) parallelepiped,

- the similarity of triangles is confronted with the sections of pyramids by planes parallel to their basis,
- trigonometry is used for the computation of the connection angle in the CH_4 molecule.

This is followed by the beginning of a more structured study of space geometry by means of some construction problems : intersection points, plane sections, ... The resulting observations are the basis of an axiomatic characterisation of planes and lines, and of a deductive approach to incidence and parallelism in space. But in the Flemish Community this deductive approach is not started before the third degree (age 16-18).

Two research reports recently issued by the CREM (Centre de Recherche sur l'Enseignement des Mathématiques ; cfr. [5] and [6] in the bibliography) include some very interesting problems and situations about this topic.

5. Other subjects of interest for mathematics education around 16 years

5.1. Regional characteristics

In the whole, there are no significant differences between the teaching systems in the Flemish or in the French Community. The main peculiarities of the two linguistic communities are occasionally pointed out in the relevant sections of this report.

5.2. Implementation strategies

These strategies are organised according to two main streams : the institutional initiative and the private initiative.

The institutional initiative is entrusted to the official inspection of the linguistic community, to some pedagogical experts of the various teaching networks and to some institutions specifically created for that purpose. The private initiative is mainly the result of the efforts of teachers associations to bridge the gaps in time and experimentation between the registration of the new curricula ant their application.

These implementation strategies are mainly put into effect by the in-service training of the teachers and the diffusion of various handbooks and pamphlets (cfr. hereafter 5.3.2 and 5.4).

5.3. Teacher training

5.3.1. **Pre-service training**

The teachers working with pupils of age 12-15 are trained mainly in specific (higher-, but not university) schools, where they obtain the diploma of "regent" (*régent*) after three years of study. The training is devoted partly to pedagogical subjects, partly to the topics related to a chosen disciplinary orientation (for instance : mathematics and sciences, or mathematics and economy, …), but which are not developed a very higher level than that reached in secondary school.

The teachers working with pupils of age 15-18 generally attend 4 years of study in a university faculty (mainly sciences) where they obtained a diploma of licence (*licencié*), to be followed by a more pedagogical training – always centered on mathematics – giving them the diploma of "*agrégé*" (diploma not at all comparable with the French homonym). The modalities of this more pedagogical training have recently been broadened in the Flemish Community and are in course of revision in the French Community.

The normal charge of a regent is generally of 22 periods/week; that of a "*licencié-agrégé*" is of 20 periods/week.

5.3.2. **In-service training**

From the institutional viewpoint, the in-service training is assumed by various people and institutions entrusted therefore by the different teaching networks, and – in the Flemish Community – by the universities too. In the French Community, a major part of this training is in the hand of teachers who often have an complete or partial charge of teaching and are thus in regular contact with pupils.

Some professional associations, working teams, and so on play a very important rôle in the in-service training of teachers, due to the various activities they organise and the publications they realise and diffuse. Those associations and teams are composed of some university professors but essentially of teachers from the primary and secondary schools. The following list is probably not exhaustive :

- the *Société Belge des Professeurs de Mathématiques d'expression française* (SBPMef),
- the *Vlaamse Vereniging van Wiskundeleraars* (VVWL),
- the *Centre de Didactique des Sciences* (CDS),
- the *Groupe d'Enseignement Mathématique* (GEM),
- the COJEREM (*Collèges Jésuites/Réflexions sur l'Enseignement des Mathématiques*),
- the *Centre d'Histoire des Sciences et des Techniques* (ALTAIR),
- the *Unité de Recherche sur l'Enseignement des Mathématiques* (UREM),
- the *Groupe d'Etudes sur les Premiers Enseignements de la Mathématique* (GEPEMA),
- the redaction team of the review *Uitwiskeling*,
- and so on …

(the corresponding addresses are listed in an appendix at the end of this report; cfr. also [7]). The annual meeting of the F.N.R.S. (*Fonds National de la Recherche Scientifique*) about didactic of mathematics may also be considered as a kind of in-service training.

5.4. Resources available to teachers

Some classical – but very important as testified by notebooks of pupils – resources are the textbooks, pamphlets, lecture notes from in-service training, and so on (cfr. [4] to [10] in the bibliography). But these resources have generally to be gathered by the teachers themselves : there are but a limited amount of schools having at their disposal a pedagogical documentation center or a well-supplied (mathematical) library.

The majority of schools are connected to the INTERNET. But the computer laboratories are seldom devoted - even partly - to mathematics. Some specific softwares, like *CABRI-GEOMETRE* are of interest to some well motivated teachers, but computer use is not usual in mathematics learning at the age 12-16.

Scientific calculators are omnipresent at the age 12-16 but graphic calculators are not, except in the Flemish Community, beginning in the second degree of the humanities (age 14-16). In the French Community, graphic calculators are compulsory at the beginning of the third degree (age 16-18) and only in the classes with 6 periods/week for mathematics.

5.5. Problems already detected

At the institutional level, the problems are connected with

- for the general and technological humanities - the fact that the "provisional" curricula have to be adapted, to fit the recent decrees, reference and finality levels,
- for the technical and vocational humanities - the fact that the corresponding reforms remain to be done … some committees are set to work but the benchwork seems gigantic !

The incertainty ambience resulting from this set of reforms deeply affects the moral dispositions of teachers, who do not always feel in harmony with the general spirit of these reforms.

At the pedagogical level, many teachers feel uncomfortable about teaching by means of problematic situations. This is mainly the case in the French Community; in the Flemish Community, the reforms are just in their beginning and their effects are not yet perceptible. Moreover, due to lack of time or expertise, some teachers are tempted to bypass some of the newly introduced topics (space geometry, data processing, …). This makes very problematic a precise evaluation of the impact on the pupils of the teaching of those new topics.

5.6. Data on national/regional results

There seems to be no result of a sufficiently general level in Belgium concerning the mathematical abilities of the pupils at the age of 16.

On a more restricted level, a mathematical test has been proposed to pupils who were beginning the second degree of the humanities (age 14). The results, summarized hereafter, relate to pupils in the third year of general and technological humanities; for a more detailed study, cfr. [11].

The test was carried out in october 1998, it comprises 34 items from three different sources :

- 10 items coming from an analoguous test proposed to pupils in the beginning of the first year of humanities (age 12),
- 15 items coming from the 1994-1995 version of the TIMSS/IEA-test,
- 9 original items.

The test was proposed to 80 classes (1742 pupils). The mean (total) score was 75/100. More precisely :

- in numeration items, the average scores are good (from 70 to 80/100),
- for questions about the fundamental operations, the results are variable according to the questions, from very good (90/100) to weak (for instance, one question about the meaning of a litteral expression yield the mean score of 51/100),
- for questions about data processing, the results are from middle-sized (60/100) to weak (for instance, two questions about a proportionnality table yield the mean score of 46 and 47/100, and one question about percentages gets the mean score of 54/100),
- in items about magnitudes, the results are middle-sized (60 to 70/100),
- for geometric items, the results are between middle-sized and good (60 to 80/100).

It is interesting to notice that the mean scores on the 10 questions coming from the test at the end of the primary school show an obvious progression in understanding : for instance +7/100 on a question about the searching of informations in a double-entry table, or +29/100 on a question about symetry axes in plane figures.

5.7. Examples of inspiring activities

The following examples are certainly not exhaustive.

- An institutional report (le "*rapport Danblon*", cfr. [3]) was published in 1991. It characterised some of the main objectives of a reform in the teaching of mathematics; this report, and the lasting interest of some personnalities, prompted the creation of the CREM (*Centre de Recherche sur l'Enseignement des Mathématiques*).
- An annual EXPO-MATHS is entirely realized by pupils of age 12-16 and teachers of various schools in the town of Mouscron.
- There is durable participation of all the linguistic communities in the mathematics olympiads.
- The annual congress of the SBPMef *(Société Belge des Professeurs de Mathématiques d'expression française*) or of the VVWL (*Vlaamse Vereniging van Wiskunde Leraars*) are important events, and the various publications of those associations are widely used.
- …

APPENDIX : SOME USEFUL ADDRESSES FOR FURTHER INFORMATION

CREM
Centre de Recherche sur l'Enseignement des Mathématiques
Rue Emile Vandervelde, 5
B - 1400 - NIVELLES
Directeur : Prof. N. Rouche

S.B.P.M.e.f.
Société Belge des Professeurs de Mathématiques
Rue de la Halle, 15
B - 7000 - MONS

V.V.W.L.
Vlaamse Vereniging van Wiskundeleraars
C. Huysmanslaan, 60/4
B - 2020 - ANTWERPEN

ICAFOC
Institut Catholique de Formation Continue/Mathématiques
Rue de Bruxelles, 61
B - 5000 - NAMUR

FORCAR
Formation en cours de Carrière de l'Enseignement non Confessionnel
Rue Montoyer, 57-59
B - 1040 - BRUXELLES

NASCHOLINGSCENTRUM VLIEBERGH-SENCIE (Centrum K.U. Leuven)
ZwarteZustersstraat, 2
B - 3000 - LEUVEN

UREM
Unité de Recherche sur l'Enseignement des Mathématiques
Département de Mathématiques de l'Université Libre de Bruxelles
Boulevard du Triomphe, CP 216
B - 1050 - BRUXELLES

GEPEMA
Groupe d'Etudes sur les Premiers Enseignements de la Mathématique
Département de Mathématiques de l'Université de Mons-Hainaut

C.B.L.
Centrum voor Beroepsvervolmaking Leraren
Universiteitsplein, 1
B - 2610 - WILRIJK

CDS
Centre de Didactique des Sciences
Faculté des Sciences de l'Université de Mons-Hainaut
Avenue du Champ de Mars
B - 7000 - MONS

GEM
Groupe d'Enseignement Mathématique
Département de Mathématiques de l'Université Catholique de Louvain-la-Neuve
Chemin du Cyclotron, 2
B - 1348 - LOUVAIN-LA-NEUVE

COJEREM
Collèges Jésuites/Réflexions sur l'Enseignement des Mathématiques
Département de Mathématiques des Facultés Universitaires Notre Dame de la Paix
Rempart de la Vierge, 8
B - 5000 - NAMUR

ALTAIR
Centre d'Histoire des Sciences et des Techniques
Département de Mathématiques de l'Université Libre de Bruxelles
Boulevard du Triomphe, CP 216
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UITWISKELING
v.u. Hilde Eggermont
Celestijnenlaan, 200 B
B - 3001 - LEUVEN

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[2] *Wegwijs in de eindtermen en de ontwikkelingsdoelen*. Ministerie. van de Vlaamse Gemeenschap ; Departement Onderwijs, 1997.

[3] *Enseigner la mathématique ? Livre blanc sur l'enseignement des mathématiques en Communauté Française de Belgique* - Société Belge des Professeurs de Mathématiques, 1991 ; 280 pp.

[4] *Les mathématiques de la maternelle jusqu'à 18 ans*. *Essai d'élaboration d'un cadre global pour l'enseignement des mathématiques*. - CREM asbl , octobre 1995, 327 pp.

[5] *Formes et mouvements : perspectives pour l'enseignement de la géométrie*. - CREM asbl , juillet 1999, 329 pp.

[6] *Construire et représenter : un aspect de la géométrie de la maternelle jusqu'à 18 ans*. - CREM asbl , juillet 1999, 392 pp.

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