the institutions. All teachers thus recruited are civil servants, except in Belgium. In principle, mobility is generally possible, although in fact in Germany and in the UK cross-regional mobility is very difficult.

II. Training

Depending on the country, the training of first cycle teachers may or may not be distinct from that of second cycle teachers. This difference is directly related to the structural differences in educational systems:

- a unique body for 7 to 16 year old pupils and specialized teachers for the second cycle, 17 to 19 year olds, in Denmark.
- specialized teachers in the first cycle as well as in the second cycle, in France and in the UK.
- specialized teachers for levels or streams of studies associated with the institutions, in Germany, Belgium, Italy and the Netherlands.

For secondary education teachers, France presents the particularity of a univalent specialization, which is also the case in the second cycle in the Netherlands. Otherwise, teachers are generally bivalent as in Denmark (2nd cycle) and Germany, trivalent in Belgium and Italy or even polyvalent in Denmark (1st cycle).

The length of training varies according to the kind of teachers and the country. Training is usually performed within the university (Germany, France, Italy) or sometimes in specialized institutions (UK). In principle, a compulsory level of qualification is required to teach mathematics. However, in those systems where teachers are bivalent, certain teachers may have to teach a discipline for which they have not been trained.

Outside of France, or even the UK, few countries face a shortage crisis for teachers in mathematics, such as the one we are now facing. On the contrary, in Belgium, Italy, Germany and Luxembourg there is a surfeit in the opposite direction and there are many graduates looking for a position.

Mathematics in the School Curricula
in Flemish Speaking Belgium

by W. Dewilde
Mathematics Inspector Secondary Education

I. The Teaching of Mathematics in Secondary and Higher Education

I.1 Structures

In Flanders, schooling is compulsory until the age of 18. From the age of 16 on, a student can choose between part-time and full-time secondary education. It
is a three-tier educational system:
— Basic schooling which includes pre-school (2.5- to 6-year-olds) and primary (6- to 12-year-olds) education.
— Secondary education which consists of a 6-year study (12-to 18-year-olds) divided into 3 levels of 2 years each.
— Higher education.

Secondary education is organized into four streams:
— general secondary education;
— technical secondary education;
— vocational secondary education;
— artistic secondary education.

Higher education is organized in two streams:
— university education
— non-university education which comprises undergraduate courses (2-3 years) and graduate courses (4 years).

To gain admission to an undergraduate course only a certified Secondary School Graduation Diploma is needed. To go to university or enroll in a graduate course of higher education an ability certificate awarded by secondary teachers or a state board of examiners is required too.

Note that for civil engineering courses the applicant has to take an admission exam organized by the university or a state examining board. For a global view of the organization of education in Flanders, see Appendix 1.

I.2 The place of mathematics in secondary education

I.2.1 Number of hours per week

In order to interpret correctly the following figures giving the number of hours per week devoted to teaching mathematics in secondary education one must note that
— vocational education has been left out;
— the figures concern only the so-called “unified structure”, which in any case will be effective throughout the country from 1994 on;
— in a total of 32 hours a week for general education and 36 hours a week for technical education, the Education Secretary determines the basic number of hours (e.g. 27 in the first year) while the education networks are free to allot the rest.
Apart from the fact that, on the whole, mathematics is given a major share in the curriculum of secondary education, it must be noted that:

— after the 3rd year, minimal hours are to be found in language-orientated sections;
— the 8 hours repeated in the 5th and 6th years are in intensive mathematics sections;
— the 5th and 6th year "science" sections offer only 4 or 6 hours twice;
— both these sections have the same number of hours in physics and chemistry and the absence of mathematics hours are devoted to biology and geography;
— some schools have a 7th year almost completely devoted to mathematics (20 hours a week) to enable students who may be lagging behind to catch up. This is especially to prepare students from non-mathematics sections for entrance examinations for civil engineering schools.

1.2.2 The programmes

In 1968, like many other countries, Belgium made a clean sweep of its previous mathematics curricula. It was the reform called "modern mathematics". Practice has shown that students, especially the younger, were not always able to cope with an often too abstract and linear approach.

In the eighties, mathematics curricula were totally reconstructed in four directions:

— reduction of the theory of sets and relations;
— postponement of the study of structures;
— reevaluation of geometry;
— increased attention to algorithms.

Teachers welcomed these new, more balanced curricula, which are a synthesis of traditional and modern mathematics, even though they are still felt to be too extensive. Concerning the curricula themselves, in the near future the following concepts could be introduced:

— mathematics as a tool to solve problems;
— mathematics as a means of communication;
— mathematics as a source of reasoning and abstraction;
— mathematics as a link between subjects.

<table>
<thead>
<tr>
<th>age</th>
<th>year</th>
<th>minimum</th>
<th>maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>1st</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>14</td>
<td>2nd</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>15</td>
<td>3rd</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>16</td>
<td>4th</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>17</td>
<td>5th</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>18</td>
<td>6th</td>
<td>2</td>
<td>8</td>
</tr>
</tbody>
</table>
I.2.3 A few figures

In the first years of secondary education, the student population ratio between general education and all other types of secondary education is 40/60. These figures, due to the "cascade system", are reversed towards the end of secondary education.

If we admit that 1/4 of the student body in general secondary education choose science or mathematics sections, we can infer the approximate percentage of students to be taken into account for possible scientific studies in higher education. These figures, which depend considerably on the schools and regions concerned, must be viewed in perspective.

I.3 The place of mathematics in higher education

I.3.1 Non-university higher education

Among the eight categories which this type of education comprises, it is in economics and mainly in graduate technical studies, e.g., industrial engineers, that mathematics is given a prevailing place. The same applies to teacher training for those who will teach in the first three years of secondary education (régents).

In all the streams of secondary education leading to these studies, a minimum of 4 hours of mathematics per week is required.

I.3.2 University education

It is of course in science and applied science faculties, e.g., training of industrial engineers, that the place of mathematics is decisive. The best preparation for such studies implies a minimum of 6 hours of mathematics per week, and preferably 8, for mathematics, physics and civil engineering studies.

A few figures about the student population of science faculties in all the universities in Flanders are shown in Appendix 2.

II. Mathematics and Engineers

II.1 Civil engineers

In Belgium, civil engineers are trained in universities specifically in applied science faculties. The studies last 5 years: 2 qualifying years, and three years of specialisation. In the first 2 years mathematics is essentially a means of selection, while in the last 3 years it is mainly a tool.

It must be noted that the student applicants have to take an entrance examination wholly based on mathematics. Besides, it is this examination combined with a reputation of high standards in these studies that explain why the best secondary students are recruited, and also the high rate of success at the end of the first year. The difficulty of the studies results in a relative stability in the number of students.
II.2 Industrial engineers

In Belgium, industrial engineers are trained in higher education colleges of technology (graduate studies). The studies last 4 years. There is no entrance examination and as a result the students’ levels are heterogeneous, some of them having studied mathematics for only 4, or 6 or as much as 8 hours per week in secondary education.

Mathematics is more used as a means of selection than as a tool.

III. Recruiting and Training of Mathematics Teachers

III.1 Initial training

Secondary education mathematics teachers can be divided into two groups:

— Regents, who are trained in higher education schools of education (called training colleges/schools of education), teach in the first stage of secondary education;

— university graduates-associate professors, who are trained in universities, teach in the third stage of secondary education and at the undergraduate level of higher education.

Note that both groups can teach in the second stage of secondary education. The training of “Regents” takes 3 years and is centered rather on practice, half of the last year being devoted to teaching three different subjects.

University graduates-associate professors are trained at a university for the last two years. Their training is rather theoretical and training periods are limited. As part of the reevaluation of teaching professions it is increasingly envisaged to give academic training to all teachers (from nursery school up to the undergraduate level of higher education).

III.2 Continuing education

Although demand for continuing education is very high, there are few opportunities and moreover these are poorly coordinated. They come from the inspectorate, from university departments or teachers associations.

III.3 Recruiting

Recruiting and appointing of teachers is one of the prerogatives of the education networks that pass through local authorities. Since the decentralization, this does not prevent heads of schools from recruiting supplementary teachers and proposing applicants.

There is a more serious problem in the near future: the relief. The number of training college and university students choosing to study mathematics has sharply dropped in the past few years. When we add to this the fact that a significant number of mathematics graduates are choosing the private sector, there is likely to be a shortage of mathematics teachers resulting in a foreseeable drop in standards
since mathematics will be taught by teachers who will not have the appropriate qualifications. Higher education teachers (graduate level) are recruited among people with a doctorate degree. Due to a shortage of applicants, graduates with several years of experience in higher education are appointed.

IV. Some Aspects of Research on the Teaching of Mathematics

Mathematics curricula for primary and secondary education are prepared by separate commissions with scarcely any efforts at harmonization. These two stages of education are separate, not only on the level of organization, but also at the research level. All Belgian research on mathematics at the nursery and primary school level is carried out in faculties in psycho-pedagogy, and therefore without the collaboration—except occasionally—of mathematicians.

As for research on mathematics at the secondary education level, it is carried out in all mathematics departments. Assessed in terms of doctorates, scientific achievement at this level remains limited. A research commission, composed of teachers from all levels and having the necessary time and means could produce well thought out, explicit documents from which the curricula commissions could draw their inspiration.

V. Conclusions and Recommendations

The following recommendations come from the first report of the Scientific Commission on the Teaching of Mathematics and Science entitled “Mathematics teaching prospects in the Belgian French-speaking community.” The fact that this extract can easily be extrapolated to the Flemish-speaking community amply demonstrates that both communities, if we except a few minor points, have the same problems to solve.

Also note that most of the following conclusions and recommendations have a much wider scope than just that of the teaching of mathematics.

— It is urgent to improve the moral and material status of teachers.
— The initial training of the teachers of the lower and upper levels of education must be harmonized.
— Continuing teacher training programmes should be seen as a duty and as a right.
— Research groups should be set up and should provide simultaneously a coordinated global view of nursery, primary, secondary, and higher education, as well as continuing education offered to teachers.
— It seems indispensable for all categories of teachers to benefit from part-time secondments and to be associated with continuing education.
— Any curriculum commission should associate representatives from other commissions that have a natural link with them as well as representatives of research groups.
— It would be useful to draw up an inventory of the equipment and books con­
sidered necessary for the teaching of mathematics at the various levels and to
inquire at the universities about the part devoted to problem solving and, in a
more general sense, about training in mathematical reflection.

— It would be desirable to suggest to science faculties that they should rethink
the concept of *agrégation* studies trying to stress and develop the link between
mathematics at the university and mathematics in secondary education.
FORMATION DES ENSEIGNANTS
TEACHER TRAINING IN BELGIUM
EN BELGIQUE
(Secteur néerlandophone)
(Flemish-speaking part)

1. QUALIFICATION REQUISE POUR ENSEIGNER
Required qualification to teach

APPENDIX 1 (Required qualification to teach), organigramme
## APPENDIX 2

TABEL II. 4 Evolutie van het aantal hoofdinschrijvingen per studierichting uitgesplitst naar geslacht en nationaliteit (Belg/buitenlander) - totaal over alle Nederlandstalige instellingen (année 1991-92)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>V</td>
<td>M</td>
<td>V</td>
</tr>
<tr>
<td>Combinaties</td>
<td>106</td>
<td>64</td>
<td>63</td>
<td>17</td>
</tr>
<tr>
<td>Wisk.-Natuurkunde</td>
<td>90</td>
<td>45</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Wiskunde</td>
<td>493</td>
<td>426</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Informatica</td>
<td>129</td>
<td>146</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Natuurkunde</td>
<td>86</td>
<td>67</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Scheik.-Biol.</td>
<td>570</td>
<td>423</td>
<td>32</td>
<td>3</td>
</tr>
<tr>
<td>Biologie</td>
<td>552</td>
<td>537</td>
<td>24</td>
<td>23</td>
</tr>
<tr>
<td>Aard- en delfstofk</td>
<td>126</td>
<td>46</td>
<td>61</td>
<td>9</td>
</tr>
<tr>
<td>Aardrijkskunde</td>
<td>182</td>
<td>172</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td><strong>Totaal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>V</td>
<td>M</td>
<td>V</td>
</tr>
<tr>
<td>Combinaties</td>
<td>139</td>
<td>71</td>
<td>85</td>
<td>35</td>
</tr>
<tr>
<td>Wiskunde</td>
<td>419</td>
<td>338</td>
<td>17</td>
<td>5</td>
</tr>
<tr>
<td>Natuurkunde</td>
<td>317</td>
<td>144</td>
<td>21</td>
<td>1</td>
</tr>
<tr>
<td>Scheikunde</td>
<td>635</td>
<td>589</td>
<td>32</td>
<td>18</td>
</tr>
<tr>
<td>Biologie</td>
<td>442</td>
<td>440</td>
<td>61</td>
<td>30</td>
</tr>
<tr>
<td>Aard- en delfstofk</td>
<td>56</td>
<td>32</td>
<td>86</td>
<td>13</td>
</tr>
<tr>
<td>Aardrijkskunde</td>
<td>54</td>
<td>74</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td><strong>Totaal</strong></td>
<td>2062</td>
<td>1748</td>
<td>310</td>
<td>104</td>
</tr>
</tbody>
</table>