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COMPUTERS IN PRIMARY AND SECONDARY EDUCATION: THE INTEREST OF AN INDIVIDUAL TEACHER OR A SCHOOL POLICY?

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Abstract—During the period of 1989–1992 the number of Dutch elementary schools that are in the possession of computers increased by 40%. More than half of the teachers in grades 4, 5 and 6 (9–11 yr) actually use the computer in the classroom. In secondary education all schools are in possession of computers. The number of teachers who use a computer for existing subjects in the second grade has doubled in the past 3 yr. Although there is a substantial growth of computer use in primary as well as secondary schools, the data show also that computer usage very much depends upon the individual teachers and is not embedded in the curriculum of existing subjects.

1. INTRODUCTION

We describe the growth of computer usage in primary education and the first phase of secondary education during the period of 1989–1992.

Since the mid-eighties the Dutch government has been pursuing a policy aimed at stimulating the use of computers in education through the Informatics Stimulation Plan (INSP) from 1984 to 1988. For the first phase of secondary education the plan comprised primarily the introduction of computer education as a subject (Information and Computer Literacy: ICL). A secondary aim was the application of new technologies in the improvement of the teaching-learning process itself. To support the implementation process, several measures were taken during the INSP-period, the most important of which being carried out within the NIVO-project (New Information Technology in Secondary Education). These measures concerned the provision of hardware and software to all schools in secondary education, development of courseware, and obligatory training for three teachers per school. During the INSP-period the government paid limited attention to the stimulation of computer usage in primary education. In a few projects the possibilities which computers could offer in this sector were examined.

The development of policy that was initiated within the framework of the INSP was continued within the framework of OPSTAP (Operational Plan Stimulation Activities and Procedures) in the period 1989–1992. For primary education this policy was carried out in the so-called PRINT/ Comenius project, which focused on supporting the implementation of computers in education and the provision of hardware. This implied that each elementary school would receive hardware during 1990–1994, based upon the ratio of one computer per 60 pupils. Furthermore each school received a starter-package of software, a printer, and a credit for the acquisition of additional software. To qualify for the provision of hardware and other support, the personnel of the school had to be trained and the targetted computer usage recorded in a school policy document. Thus with the introduction of computers in primary education the government aimed first at the usefulness of the computer for educational purposes and ultimately to support the realization of educational goals.

The policy for the first phase of secondary education during 1989–1992 focused upon further integration of computer education in the curriculum and upon the integration of information technology elements in existing subjects. After a period of dissemination of hardware and the stimulation of computer usage during 1984–1988, the most important goal in the period 1989–1992

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was the broadening of computer usage in secondary education. This meant that beside its use in computer education, the application of the computer in existing subjects had also become an aim.

2. METHOD

The data were collected in the context of the Dutch contribution to the international study "Computers in Education" (COMPED). In 1989 the data collection was carried out among a sample of primary and secondary schools. In 1992 the same schools as in 1989 were approached and an additional sample was drawn to correct for mutations that occurred in the period of 1989–1992 in the pool of schools due to mergers, and increasing or decreasing numbers of pupils. The results that are presented are based upon survey data acquired from in total 832 primary schools and 854 secondary schools. Considering the size of the sample and the achieved response rate (92%), the results can be considered respresentative.

Data collected in 1989 from several other countries such as Germany, France, Japan and the U.S. are included for comparative purposes.

3. RESULTS

Primary education

In spite of the lack of broad stimulation by the government during the INSP-period, in 1989 a little more than half of the elementary schools were in possession of computers. On average these schools had three computers. Most schools financed these computers from their own funds or participated in a local or regional introduction-project. The most frequently used type of computers in 1989 were: P2000/MSX computers (58%) and C64/AppleII (22%)[1]. In the period 1989–1992, the number of elementary schools with computer hardware increased from 51% to 89%. The influence of the Comenius project on the dissemination of computer hardware in primary education is depicted in Fig. 1. This figure is based upon the overlap in the sample of schools that participated in the research in both 1989 and 1992, forming a sub-group ($n = 419$) of the total number of schools that were approached. It should be noted that the precision of the percentages presented below regarding the sub-groups is lower than that of the percentages that apply to the population as a whole; the deviation however is small and does not affect the trend in the results. Furthermore, in the interpretation of the results a slight under-representation of schools that participate in the PRINT/Comenius project should be taken into consideration. The main reason given by these schools for not participating in the study is that the computer issue already requires too much of their time on activities that are part of the PRINT training program. Furthermore, these schools
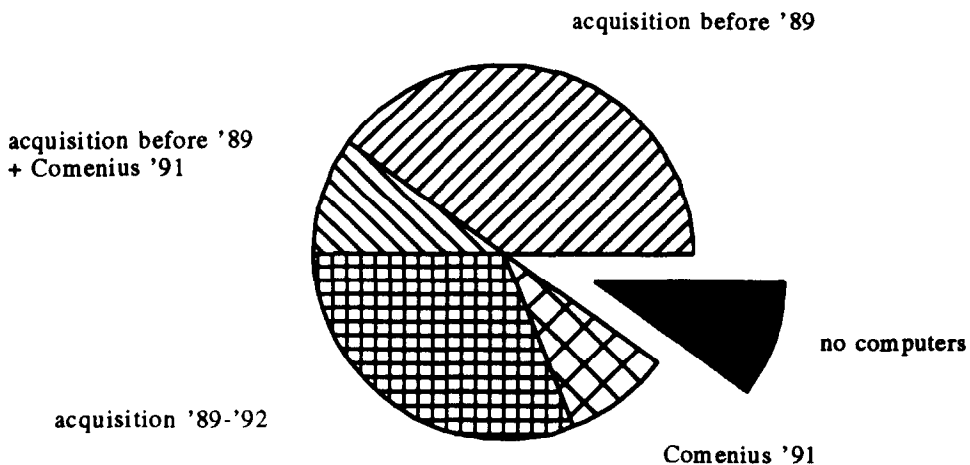

Fig. 1. Overview of the acquisition of computer hardware by elementary schools.

indicate that they are frequently approached for studies concerning computers, resulting in a certain research fatigue.

From the results it becomes apparent that of the 51% of schools which were already in possession of computers in 1989, one out of five schools received further computer hardware in 1991 through the Comenius project. The increase in the degree of dissemination of computers in primary education in the period 1989–1992 can be explained by 9% of the elementary schools having received their first computer in 1991 through the Comenius project and 30% of the schools having acquired computer equipment on their own initiative. Elementary schools that still were not in the possession of computers (11%) will be provided computers in the coming years (1992–1994) through the Comenius project.

Based on the 1989 results it is apparent that almost all the elementary schools that are in the possession of computers make use of them. On average 75% of the teachers in the grades 4–6 (age 9–11) who are employed by a school in the possession of computers actually make use of these computers in the classroom. Over the past 3 yr, in these same schools, the percentage of teachers who make use of the computer in the three highest groups has slightly decreased from 75% to 68%. In schools that have received the equipment in the period 1989–1992, the percentage of teachers who actually make use of it is 39% —a significantly lower percentage than in schools that acquired the equipment before 1989. In early 1992, 61% of the schools that received their first computer through the Comenius project in 1991 do not make use of this equipment for teaching purposes. Among the schools that acquired computers from their own funds over the past 3 yr, 37% do not yet make use of them for teaching purposes. It can be assumed that these latter schools use the computer solely for administrative purposes. In the group of schools which received their first computers through the Comenius project, 48% do not yet make use of the computer in one of the three highest grades. This means that in little more than half of this group of schools the Comenius computer is used by at least one teacher. It also indicates that at present the influence of the Commenius project and the support during the implementation process via PRINT do not yet find expression in a high degree of computer usage in schools.

Since the year in which the equipment is delivered to the schools is considered to be an orientation year, such an effect would be expected at that time. The actual implementation is planned for the subsequent years. The PRINT strategy perceives the implementation of the computer in education to be an innovation process which takes several years. The results of the COMPED study demonstrate that in the year in which the equipment is delivered, widespread use of it in the classroom indeed is not the case. The same applies to schools that have introduced computers on their own initiative over the past few years.

Although the number of elementary schools with computers has increased by almost 40% during the past three years, the average number of teachers who make use of this equipment in grades 6, 7 and 8, has decreased from 75% (among the 51% of schools in possession of a computer in 1989) to 56% (among the 89% of schools in possession of a computer in 1992). This fall, however, does not entail that computer usage has decreased in primary education. On the contrary, due to the increase in the number of schools that are in the possession of computers, a significant growth has taken place in the number of teachers who make use of the computer in primary education.

If we compare the Dutch situation in 1989 with the situation of several other countries[2] it becomes apparent that the proportion of primary schools that make use of the computer in the Netherlands was higher than for example in Portugal (29%) and Japan (25%), comparable to the percentage in Belgium, and lower than in Canada (99%), France (92%), Israel (62%), New Zealand (78%) and the U.S. (100%). The elementary schools that made use of the computer in 1989 on average were in the possession of three computers. This implies an average of one computer per 80 pupils. Compared to elementary schools in other countries, computer–pupil ratio is unfavourable to The Netherlands. For example in Belgium, Canada, France, Israel, Japan and the U.S., elementary schools possess one computer for every 30 pupils. The percentage of teachers that make use of the computer in the highest grades of primary education in 1989 was comparable to the situation in the U.S. In Israel and New Zealand the degree of use is higher. respectively 96% and 92%. It is remarkable that in these two countries the number of subjects for which the school has courseware is comparable or even lower than in Dutch schools, where courseware is available on average for four

subjects. That the number of subjects for which software is available is not linearly related to the degree of computer usage also becomes evident in the situation in the U.S. where elementary schools on average are in the possession of courseware for nine different subjects and where the percentage of teachers who make use of the computer was comparable to the Dutch percentage in 1989.

The practical applicability of the software in the teaching–learning situation is an important criterion in the decision of the teacher to implement the courseware in the classroom. That not all courseware is perceived as being useful became evident in the judgement of teachers of the starter pack that was introduced in 1991 in the PRINT/Comenius project[3]. The starter pack included the following software:

(a) Word: a wordprocessor;
(b) Corel Draw: a drawing program;
(c) DOCO: a database for the documentation-centre;
(d) CBSO: a computer-run spelling exercise;
(e) GLOBES: a program to stimulate inquiry learning;
(f) Thuis in het Milieu (At home in the environment): program for environmental issues;
(g) Wereld rond tafels (the world around multiplication tables): exercise-program for multiplication tables;
(h) Clowns: a game for young children with emphasis on the recognition of shapes and colors.

As is evident in Fig. 2, of the eight programs in the starter package only three are recommended by 50% or more of the teachers to their colleagues for their perceived practical utility.

Summarizing, in Dutch primary education almost 90% of the elementary schools are in the possession of computer hardware. Approximately three-quarters of the elementary schools have up to now acquired their first computer on their own initiative. The number of computers per school is low, resulting in a relatively high ratio of pupils per computer. The proportion of teachers who use the computer, in schools that have possessed computers for more than 3 yr, seems to have stabilized over the past years, at round 70%. The percentage is considerably higher than in schools which have
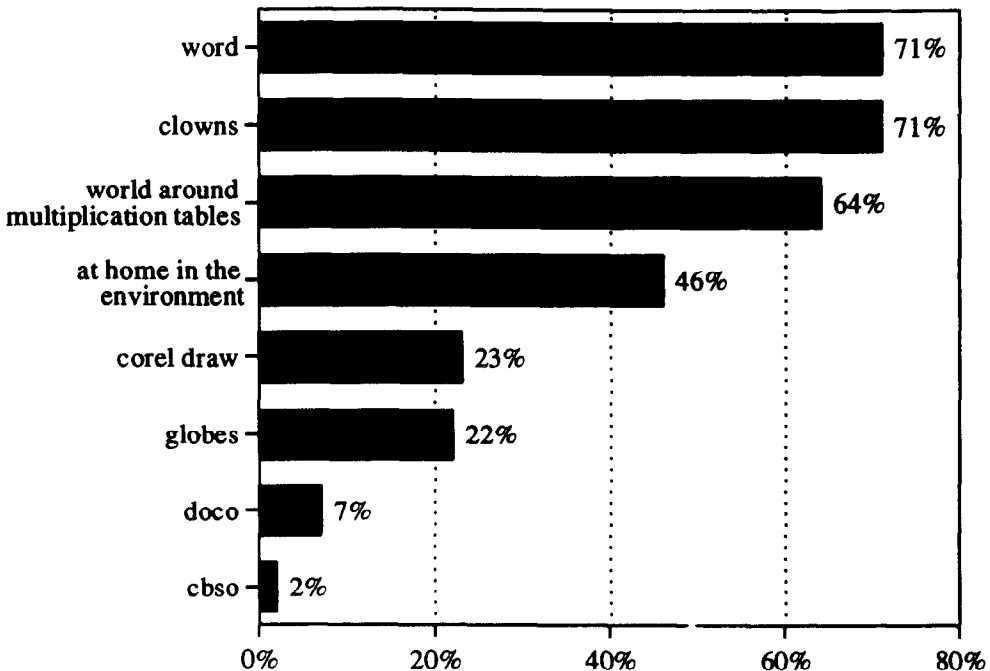

Fig. 2. Programs from the starter-pack which are recommended by teachers to their colleagues for their practical utility.

started with the introduction of computers in education in the past 3 yr (39%). For the time being there is no difference in the degree of computer usage between schools that have introduced the computer in the past 3 yr on their own initiative and schools that were stimulated by facilities in the context of the PRINT/Comenius project. Half of the programs which were provided to schools in the PRINT/Comenius project are considered useful by more than one-quarter of the schools.

Secondary education

In the spring of 1989, 88% of secondary schools were in the possession of computers. On average there were 21 computers per school, most of which were equipped with the MS-DOS operating system[1]. Even though the policy was aimed at having provided computers to all schools at that time, this goal could not be realized due to delays in the delivery of the equipment. As projected, by 1992 all secondary schools were in possession of computers.

As intended in the NIVO project, in 1989 the computer was most frequently used for computer education, which was taught in the first three years of secondary education at 88% of the schools. In 1992 this percentage rose to 94% — only at 6% of the secondary schools computer education had not yet included it in the timetable in one of the first 3 yr. From a number of these schools it is known that computer education was included in the timetable of one of the higher grades. All teachers who taught computer education made use of the computer during their classes. Besides the introduction of computer education in the curriculum of secondary schools, the NIVO-project aimed at the integration of the computer with existing subjects. Figure 3 shows that within the second grade of secondary education this aim had hardly been achieved in 1989 (Mathematics 12%, Natural Sciences 6% and Dutch 7%). As has been mentioned, the policy of the past years has been aimed at a broadening of computer usage within existing subjects. In Fig. 3 it becomes apparent that computer usage has at least doubled in each of the studied existing subjects. The strongest growth has taken place within the Natural Science subjects: from 7% in 1989 to 25% in 1992.
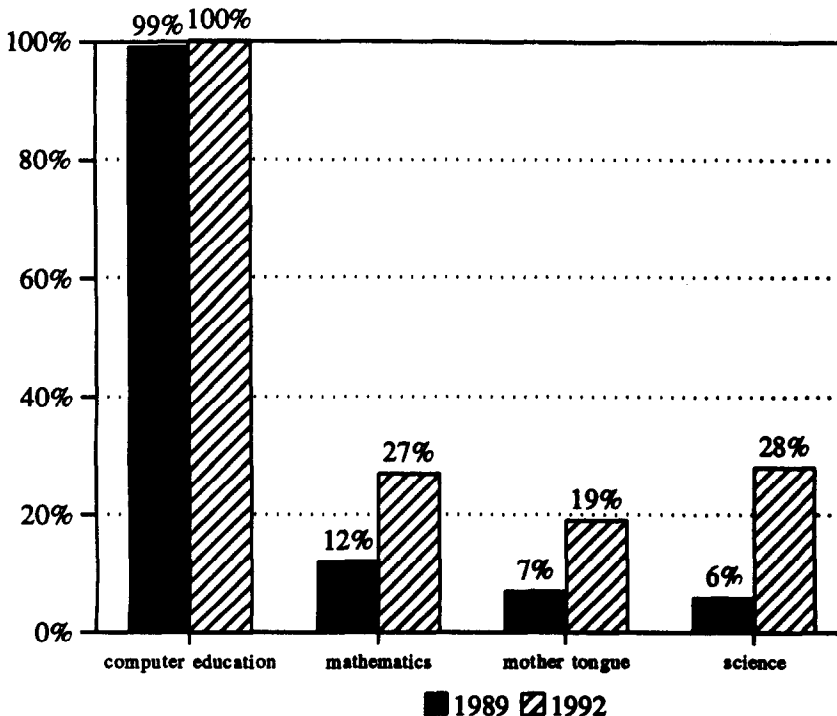

Fig. 3. Percentage of teachers who used computers for teaching aims in the first phase of secondary education in 1989–1992.

In addition to the teachers who make use of the computer, the percentage of schools in which the computer is used within an existing subject by at least one teacher is an imortant indicator for the degree of computer usage in education. This degree of implementation of computers is shown in Fig. 4 for the years 1989–1992.

Even though Figs 3 and 4 record a notable growth of both the number of teachers and the number of schools that make use of the computer for teaching aims, it has to be noted that the present data do not give an indication of the nature and intensity of the usage. On the basis of the COMPED data, however, it can be assumed that at the time of the study the computer usage by teachers within existing subjects was mainly incidental in nature. Only 1–2% of the teachers, who at that time used computers within existing subjects, made use of the computer frequently and possibly integrated the computer in the curriculum. Further analysis of the increase of computer usage in existing subjects since 1989 shows that this increase can almost entirely be attributed to teachers who work within a department in which, in 1989, no other teacher had yet made use of the computer in the second grade (Fig. 5). The policy aim of broadening the computer usage within existing subjects has hence been achieved among schools, but not within the various departments of a school—especially not within schools that in 1989 already made use of the computer in existing subjects. The present computer usage in existing subjects of the first phase of secondary education therefore is an activity that very much depends upon the individual teacher and is not embedded in the curriculum. Also results from other studies show that the use of computers in education strongly depends upon the interest of individual teachers[4].

In comparison with secondary schools in other countries, in 1989 the availability of computer hardware was relatively favourable to The Netherlands. At that time, the pupil/computer ratio in The Netherlands was 31. In 1989, only in Canadian and U.S. schools was this ratio more favourable, respectively 17 and 22. In comparison with other EU-countries such as Belgium, Germany and France, where the pupil/computer ratio was 37, the availability of computers is highest in The Netherlands. It is remarkable that the pupil/computer ratio is very high in Japan (292). Possibly this ratio can be explained by the late introduction of computers in secondary education in Japan (1987).
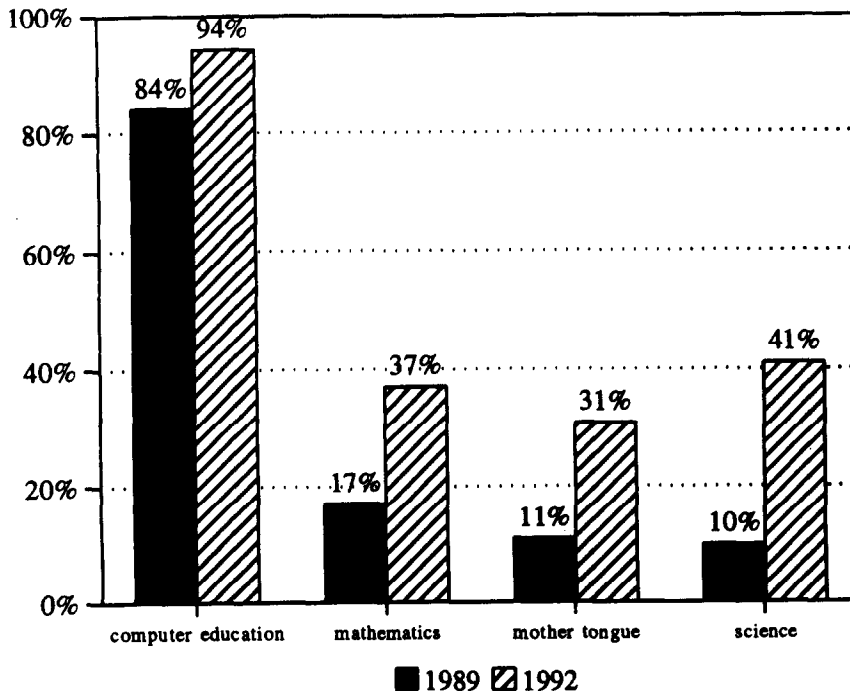

Fig. 4. Percentage of secondary schools with at least one teacher who uses the computer for teaching aims.

mathematics ⊢ 100%

mother tongue ⊢ 100%

science ⊢ 100%

0%   20%   40%   60% . 80%   100%

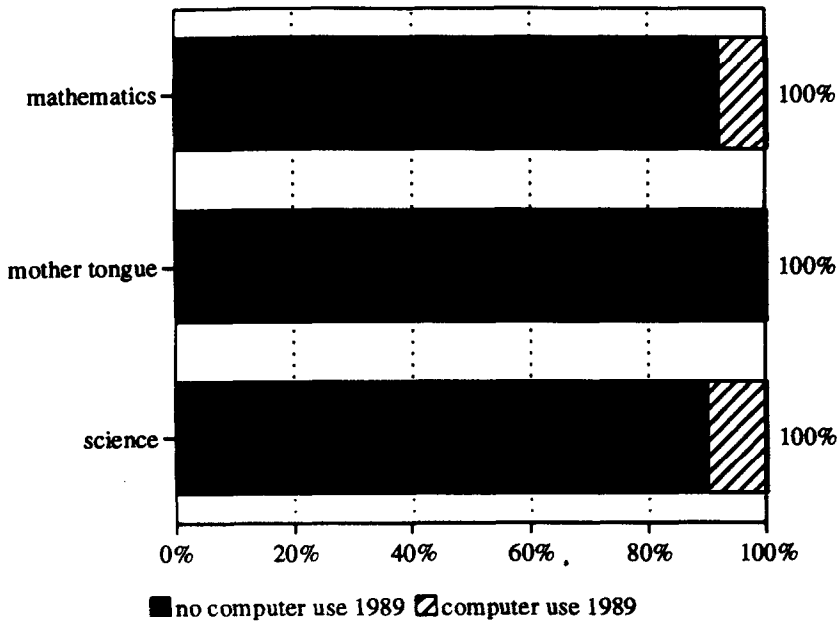■no computer use 1989 ▨computer use 1989

Fig. 5. Subject of teachers who in 1989–1992 started using the computer for teaching aims within existing subjects in the second grade of secondary education.

Concerning the availability of courseware, Dutch schools are in the possession of great variety of programs. This can be seen as one of the achievements of the NIVO-project which saw to it that all secondary schools were provided with a number of different programs via the NIVO starter pack. In 1989, more than half of the secondary schools were in the possession of programs for the subjects of computer education, mathematics, natural sciences, Dutch language and foreign languages, for social subjects (geography, history, social studies and civics) and for commercial subjects (economics, knowledge of business and law). The Netherlands was among the group of countries with the highest availability of software for subjects in secondary education.

As has been pointed out, in The Netherlands the high degree of dissemination of courseware for various subjects did not lead to a similar increase in the usage of computers in these subjects. Even in comparison with countries such as Switzerland and Portugal that started later with the introduction of computers and in which the degree of dissemination of software for the various subjects is lower than in The Netherlands, in 1989 the computer usage within subjects in secondary schools was lower. Also in Germany and New Zealand, that introduced computers in education more or less at the same time as The Netherlands and in which the pupil/computer ratio is more unfavourable than in The Netherlands, the computer was more frequently used within subjects. It is remarkable that despite the high degree of dissemination of software, in no other country has the lack of usable software been seen as a hindrance in the implementation process as frequently as in The Netherlands. The explanation for this apparent contradiction has to be searched for in the practical usability of the courseware that was available to schools in 1989.

Summarizing, all secondary schools are in the possession of computer hardware. In 1989, secondary schools in The Netherlands were in the possession of relatively many computers and software when compared to schools in other countries. The practical usability of a number of the available programs was rated by teachers as unsatisfactory. Almost all schools (94%) now include the subject of computer education in the timetable of one of the first three grades. Within this subject all teachers make use of computers. Although in the past 3 yr the percentage of teachers who teach in the second grade of secondary education and who make use of the computer in existing subjects has at least doubled, this frequently relates to individual teachers within a department in which the computer until then had not been used for this purpose.

4. DISCUSSION AND RECOMMENDATIONS FOR POLICY

In The Netherlands the introduction of information technology in primary and secondary education has taken an important place in government policy over the past few years. Starting in 1986, secondary education was provided with computer equipment; in 1990 a start was made by the government with the provision of computers for primary education. For both education sectors it holds true that at the same time as the hardware was delivered, courseware became available and that as a condition for delivery a number of teachers had to participate in training aiming at the usage of computers. The manner of introduction of computers in both secondary education and primary education hence coincides on the main points: availability of hardware, software and training. The policy in the area of information technology for primary and secondary education also took into consideration the most important hindrances to the usage of computers in the classroom which were indicated in 1989 by teachers, computer coordinators and directors of schools: too few computers, insufficient usable software and lack of knowledge. Also in other countries these factors were the most important bottlenecks in the implementation of computers in education[5]. A fourth bottleneck mentioned in many countries is insufficient time for introduction. It holds true in The Netherlands for both primary and secondary education that no policy measures were taken to overcome the shortage of time teachers experienced during their training on the possibilities and the implementation of the computer within the classroom. In the innovation literature it is known that the effectiveness of implementation stimulating measures often is determined by the degree of internal coherence of the measures[6]. In relation to the introduction of computers in education this could imply that the lack of facilities, for example in the form of non-teaching-hours to enable teachers to prepare the integration of the computer into the curriculum, negatively influenced the effectiveness of other measures.

Many teachers first want to gain more knowledge about the possibilities of the computer for educational ends before substituting the security of their teaching routine by the insecurities which accompany the introduction of the computer. This can be concluded from the doubts which many teachers felt concerning this point. In 1989 more than 60% of non-user teachers indicated that the educational value added by the computer was not clear to them. This issue received attention in the design of the training programmes which had to be attended by primary school teachers as part of the PRINT/Comenius project. However, on the basis of 100 telephone interviews which were conducted among teachers who followed the training programme in the school-year of 1991/1992, it became apparent that in their opinion it is assumed in the school programmes that with the arrival of the Comenius computers, computer usage is introduced. As has been pointed out earlier, this is only the case in a limited number of schools and that, when the Comenius project started, about three-quarters of primary schools had already acquired a computer on own initiative. Therefore, these primary schools had a starting point other than is assumed in the training programmes, and hence the programmes catered insufficiently to the needs of teachers who already have decided to introduce the computer. Differentiated training in which the degree of computer implementation already realized at the school level, can be expected to have a positive effect on the effectiveness of measures aimed at promoting the further growth of computer usage in schools.

Computer usage in secondary education within existing subjects is characterized by the incidental nature of its application by individual teachers. Since the aim is to integrate computers in existing subjects, in the context of the revised curriculum of lower secondary education, it has to be noted that to achieve this aim, further growth in the usage of computers is needed. At school level hardly any systematic integration of the computer has been found in departments teaching existing subjects, especially in those in which some teachers had made use of the computer by 1989, the growth of computer usage has stagnated. The growth of computer usage over the past few years has primarily taken place due to individual initiatives by teachers in departments in which the computer was not in use in 1989. Additional stimulating measures are needed to give computer usage an established place within existing subjects. Furthermore it seems to be important that good examples of practical programs come available that illustrate the added value of computer use in existing subjects.

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