The Impact of Information and Communication Technology on the Teacher

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Summary

Introduction

In spite of all efforts made, the use of Information and Communication Technology (ICT) in primary and secondary education in general is disappointing. High expectations with regard to the potential of computers in education have not been met.

Initially, attempts to introduce the computer in education were technology-centred, the role of the teacher in the innovation process being neglected. Many innovators considered the teacher to be merely a barrier which had to be overcome. These innovators tended to view teachers as executors of prescribed tasks, implying that detailed tasks had to be formulated in order to get teachers to use computers in the classroom. This approach proved to fall short. Gradually, the approach shifted from technology-centred towards teacher-centred thinking. More and more, the teacher is perceived to be the crucial factor in the innovation process. Simultaneously with this shift from a technology-centred to a teacher-centred innovation approach, educational theorists started to advocate a shift from teacher-centred towards pupil-centred learning environments. This shift is expected to influence the role of the teacher to a large extent.

Until now, only few studies focussed on the impact of ICT on the teacher. Research has primarily addressed the implications of learning with ICT for students or factors influencing the implementation of ICT by teachers. In order to gain more insight into the changing roles of teachers using ICT in their (primary and secondary) classes, the European Commission (EC) put a study of the impact of ICT on the role of the teacher to tender. This study, which was initiated by Directorate General XXII of the EC, was carried out in five countries, involving researchers from Belgium, Germany, Ireland, The Netherlands, and Spain. The study was co-ordinated by the Institute for Applied Social Sciences (ITS) from the University of Nijmegen, The Netherlands. The focus of the project is on the way ICT affects the practice of the teacher, and the way this practice may be improved.
The Impact of Information and Communication Technology on the Teacher

Theory

Implementation of ICT in education

Many studies have addressed implementation issues with regard to ICT in education, resulting in an extensive list of relevant factors and actors. These may be categorized into four levels: 1) the community (national / regional / local level); 2) the school; 3) the teacher and the learning environment; 4) the pupils. The results of the studies as to which are the most important variables influencing ICT use in the classroom, however, are inconclusive. There is an interaction of factors which, according to some studies, depends on the stage of the implementation process.

The community level and the school level

In order to foster the implementation of ICT in classroom practice, several preconditions have to be met. These may to a substantial part be influenced by the policy towards ICT which is adopted at the community (i.e. the national, regional, or local) level. Among these preconditions are giving financial support to schools, fostering courseware development, fostering adequate teacher training, providing technical and pedagogical support, and stimulating the use of ICT by integrating ICT related abilities in the curriculum and examination requirements.

At the school level, the implementation of ICT may be stimulated by:

- providing access to hardware
- acquiring (educational) software or allocating budgets for the acquisition of software
- setting up internal support (by an ICT co-ordinator and a system operator)
- stimulating communication about ICT in the school
- stimulating teachers to use ICT
- stimulating the school staff’s professional development, and
- allocating time for ICT-related activities to the staff.

The teacher modelling the learning environment

Optimal learning processes cannot be obtained unless there is an optimal learning environment. The teacher plays a crucial role in modelling and managing the learning environment. In this respect, teachers fulfill numerous tasks: selecting goals, selecting content, selecting media, selecting learning materials (including courseware), selecting teaching methods, grouping pupils, allocating time for the activities, enabling differentia-
tion, interacting with pupils, monitoring pupils’ progress, and assessing the learning effects.

The use of ICT may influence the learning environment in terms of infrastructure, classroom structure, grouping, learning tasks, interaction patterns, behavioural control, mental effort, interaction, time schedule, teaching and learning methods, etc. The nature of this influence is to a large part determined by the teacher. The skills of teachers that most influence their uses of computers are, according to studies, those skills related to their competence in classroom management activities, to their pedagogical skills and, less importantly, to their computer-handling technical skills. Fear is often cited among teachers as a reason for resisting the use of computers in the classroom: fear of losing control of ‘centre stage’, or fear of ‘looking stupid’ in front of the class. A teacher’s adjustment to the use of technology requires considerable effort, new knowledge, and a willingness to change existing teaching strategies.

Studies show it is a general practice that using ICT implies a challenge to traditional whole-class teaching. The rise of individualized learning and co-operative learning necessitates specific teachers’ skills in terms of individual management and group management. Moreover, the increased use of technology reveals a new but complex challenge to the skills of teachers. At the micro level, teachers are faced with many types of decisions and are required to fulfill many different tasks related to the daily use of ICT (decisions about when pupils should use computers, how to link their use with other instructional activities, which software to use, how to co-ordinate use of computers among different classes and among pupils within a classroom, etc.). These new tasks require observational and management skills different from those that teachers usually apply.

Impact on the role of the teacher

The teachers’ role in the classroom can be viewed as a continuum. At the one end is the teacher as a traditional lecturer and importer of knowledge. This is in accordance with objectivist views of learning. At the other end is the teacher as a coach, observer, and facilitator. This fits into the constructivist view of learning. Teaching in pupil-centred learning environments requires a different attitude of the teacher than teaching in traditional instructional settings. Teachers are expected to move to facilitating individualized, interactive, media-based learning, stimulating their pupils to accept far greater responsibility for their own learning. Feedback in pupil-centred learning environments may be characterized as guidance and facilitation. Guidance means assisting the learner in
coping with the learning environment through suggested learning strategies, help options, procedural advice, hints and prompts. Facilitation emphasizes the empowerment of the individual in deploying his or her own cognitive strategies. Initially, teachers may be expected to serve as instructors to pupils in ICT-related activities. Later, as the pupils gain more experience, the teacher's role should move to that of a coach. In assessments of ICT projects in education, teachers indeed often report a shift in their role, from being the central manager of the learning process towards becoming a facilitator or coach. Since many applications of ICT prove to be incorporated in existing teaching routines, instead of facilitating more pupil-centred learning, the desired shift of responsibility to the learners, however, is often lacking.

An issue which is of importance with regard to the role of the teacher, is related to the abundance of information which becomes available when ICT is being used, especially when multimedia and communication technologies are available to pupils. Consequently, the teacher loses track of all the content that is available to the pupils. This means teachers have to get used to the idea that they have less control of the content their pupils may access. As a consequence of this, teachers have to be able to admit to their pupils that they don't have all the answers. This is a significant change in the role of the teacher.

Method

In the empirical part of this study, twenty-five case-studies were carried out in primary and secondary schools. In order to maximize the chances of obtaining 'examples of good practice' with regard to ICT use, technology-rich schools were selected (five per country).

Within this part of the study, the following questions were addressed:
1) What is the situation with regard to resources and support for teachers using ICT?
2) How is ICT actually being used by teachers?
3) What is the impact of ICT use on the teacher?
4) How may ICT use by teachers be stimulated?
5) In what respect do differences occur between primary and secondary education regarding the questions posed above?
6) In what respect do differences occur between the five countries regarding the questions posed above?
Within the framework of the case-studies, the following activities were performed: 
Conducting interviews with the school principal and/or ICT co-ordinator (25 interviews); 
Conducting a survey among teachers (processed by 403 teachers, 191 of whom use ICT in their classes); 
Conducting classroom observations (90 lessons, 50 of which in primary classes, and 40 in secondary classes).

The part of the study that was carried out in The Netherlands also includes interviews with 32 teachers from 16 schools (9 primary and 7 secondary schools).

Results

Factors influencing the use of ICT by teachers

In primary and secondary education it is common that every teacher may decide for himself (or herself) whether he (or she) will use ICT in classroom practice. In this respect, the teachers’ beliefs and skills are crucial. These factors are not only critical with regard to the question of whether or not to use ICT in educational practice, but also with regard to the question of how ICT will be used. Teachers have to see the advantages of ICT use in order to be motivated to implement it in their teaching practice. Apart from this, if teachers are not confident about their capabilities in handling computers, this may hamper their willingness to introduce technology in their classroom. The reason for not using ICT that is mentioned most frequently by teachers from the case-study schools, is because they are not familiar with ICT or they feel unsure about it. Lack of hardware (in the classroom), lack of suitable software, and lack of space in the curriculum also were mentioned quite often as reasons for not using ICT in the classroom, but these barriers are clearly not as important as lack of familiarity with ICT.

According to the teachers who do use ICT, one of the two largest barriers to (the increase of) the use of ICT in education is the limited availability of time for professional development. Insufficient quality of pre-service training is the second main barrier mentioned by these teachers. Using ICT themselves and communicating with colleagues are, according to the teachers, the means that best helped them acquire skills with regard to ICT use. According to the school principals and ICT co-ordinators from the case-study schools, the main obstacles to the implementation of ICT in the schools are lack of money and lack of adequate teacher training. Principals as well as teachers feel training
too often focusses on technical issues, instead of highlighting the didactic consequences and opportunities of ICT use in the classroom.

Many teachers in the case-study schools point at insufficient access to hardware as being a significant impediment to ICT use. When computers are located in a separate computer room, teachers may feel it is more difficult to integrate the use of technology in regular teaching practice. The use of computer rooms has to be scheduled in advance, and the duration of the ICT-related activities has to be planned carefully. On the other hand, because of lack of money as well as lack of space it is not possible to fit classrooms with lots of computers. In conversations with teachers, lack of space is another issue which is often put forward as a serious problem with regard to incorporating ICT into daily practice. Changing learning environments call for a different kind of school buildings, in which there is sufficient room for equipment and where there are facilities for autonomous learning, inside as well as outside the classrooms.

Actual use of ICT by teachers

There are some notable differences between primary and secondary schools with respect to the use of ICT. Firstly, in secondary classes, ICT proves to be put into action considerably less often than in primary classes. Secondly, there is more variety in ICT-related activities in primary education. In primary schools, applications that are used (quite) frequently, are drill and practice exercises, games or adventures, problem-solving applications, and word processing. Games are often inserted as an interlude between exercises. In secondary schools, the only applications that are used (quite) frequently, are word processing, and drill and practice exercises. It is striking that the use of problem-solving applications proved to be almost absent in classes we observed in secondary schools. Overall, in primary schools the use of ICT appears to be integrated in daily teaching practice to a larger extent than in secondary schools. In secondary schools, the use of ICT is often restricted to specific classes as well as specific subjects. The curriculum is, by several secondary school teachers, considered to hinder the increase of ICT use.

Innovative approaches show the use of ICT for enhancing creativity (e.g. writing texts, producing pieces of work, graphs, or drawings), for the gathering and adapting of information, for simulation of real-life activities, or for stimulating social processes. In these settings pupils in general know what they are expected to do, and they are largely working on their own or in pairs at the computer. This leaves the teacher as a coach and facilitator, who monitors the pupils’ progress in the background, and stimulates pupils to solve problems themselves or in co-operation with classmates. Instead of directly
answering pupils’ questions or taking control of their keyboard, the teacher gives hints or clues. In this way teachers allow their pupils some degree of experimentation. In these cases, computers are looked upon as tools that facilitate the learning process rather than as ends in themselves.

The less innovative approaches typically show the use of ICT for drill and practice exercises or for exercises in which pupils are expected to follow detailed instructions step by step. Feedback in these cases is often either absent or rather general instead of tailored to the pupils’ needs. Several teachers, however, appreciate this kind of ICT use, since these applications automate time-consuming activities, thus leaving time for the teacher to give more attention to pupils who need extra help.

The innovative role of the teacher in a changing learning environment

The most notable influence of ICT use on teaching methods in classroom practice is that it brings about a shift from whole-class teaching to pupils working individually, in pairs or in small groups. During classroom observations, working in pairs at the computers was the grouping arrangement that was noted most frequently in primary schools. In secondary schools, pupils working individually were observed about as frequently as working in pairs. From the interviews, the conclusion may be drawn that many teachers, especially secondary school teachers, prefer pupils working individually at the computer. Some teachers report they have to stimulate pupils who are working collaboratively to do their share of the work instead of sitting back and watching their partners do the job. Some teachers also point at the increasing noise level when pupils are working together, which may in their opinion disturb the rest of the class. On the other hand, some innovative uses of ICT that were observed in the case-studies, show that working in groups is promoted by teachers as part of the educational strategy.

Educational theorists who are adhering to constructivist views, promote open-ended, pupil-centred learning environments in which pupils decide to a large extent what, when, and how learning will occur. The classroom observations show some innovative approaches of ICT in which pupils indeed have the opportunity to decide to a certain extent what activities they will carry out. However, the goals for the lessons that were observed, were always set by the teachers. Apart from this, several applications of ICT that were observed should rather be characterized as structured instead of open-ended, thus contributing more to behaviourist than to constructivist ideas. From the classroom observations, the conclusion may be drawn that teachers to a large extent are setting the same goals for all the pupils in the same class.
A majority of ICT-using teachers have the impression that using ICT results in a shift in their role, the teacher acting more as a coach than as a lecturer. A majority also feel that using ICT enables them to spend more time assisting pupils who need extra attention, and it enables them to do their work more efficiently. From the classroom observations it may be concluded that innovative uses of ICT indeed show teachers who are limiting the amount of direct instructions, stimulating pupils to solve questions themselves, and providing help when necessary. These approaches of ICT use were rated to be more pupil-centred than teacher-centred. In these cases there often was more emphasis on pupils constructing knowledge than on teachers transferring knowledge. However, if the teacher is walking around the classroom, instead of lecturing, this does not necessarily mean the learning environment is pupil-centred, with an emphasis on pupils actively constructing knowledge. The pupils’ actions may be determined by the computer programs instead of by the teacher, thus leaving little room for pupil initiative. During the lessons that were attended, pupils in general were not more in control than their teachers. The majority of teachers who participated in this study exactly tell their pupils what they are expected to do before they start working at the computers. The majority also regularly check how their pupils are doing while they are at the computers.

Monitoring the pupils’ progress is more time-consuming when pupils are to a large extent in control of their own learning, which implies they are working at different tasks, at a different pace, and at different levels. Another complicating factor is that it is difficult to monitor what pupils are doing when they are working at computers that are located outside the classroom, which was observed in some cases. As a consequence of this, teachers may feel less secure about the actions that are being undertaken by their pupils, which in turn may lead to their feeling insecure about the results of the learning process.

A factor which has a severe impact on the role of the teacher, is that some pupils are better at the computer than the teacher. Teachers have to be willing to accept this, and they have to be willing to learn from their pupils with regard to the use of ICT. This seems to be one of the key issues which are separating ICT-using from non-ICT-using teachers, as may be concluded from this field study.

In the lessons that were observed it was quite often the case that all pupils were expected to work through the same learning content and perform the same learning activities. There were not many remedial activities, nor higher-level activities. Within the framework of drill and practice exercises, some degree of differentiation is achieved by allocating more time at the keyboard to pupils who are lagging behind their classmates.
In many cases, however, teachers do not make use of the potential of ICT to facilitate differentiation and provide education which optimally fits the characteristics of the pupils. This subscribes to the statement that ICT is often integrated in current teaching practice, instead of making use of the extra potential.

With regard to the teacher's workload, a substantial group of ICT-using teachers in the case-study schools thinks using ICT does not lead to major differences, as compared to a situation without ICT use. Of course, the teachers' views with regard to the impact of ICT on their workload may be influenced by the way they are actually using ICT, by their skills with regard to the use of ICT, and by their amount of experience with ICT. Some innovative approaches require more preparation time than traditional approaches. During the lessons, innovative approaches may also require more energy from the teacher. On the other hand, these approaches may be considered by the teacher to be more rewarding than traditional approaches.

The majority of teachers in the case-study schools who do use ICT in their classes think ICT has a positive impact on the efficiency of their work. These teachers in general have very favourable ideas about the influence of ICT on the pupils as well, especially with regard to the pupils' motivation, and their interest in the subject.

**Discussion**

ICT provides opportunities to enhance new learning environments, which are more tailored to current and future needs in education. There are two main reasons for creating these new learning environments. First, the emerging of the ‘information society’ calls for new skills, especially with regard to information handling. Second, there is the problem that school learning which is abstracted from reality may lead to ‘inert knowledge’, which is not likely to be used in situations outside school. New learning environments should be created that stimulate pupils to process information autonomously and to actively construct knowledge, the teacher being a facilitator of this process. ICT may serve as a valuable tool in these new learning environments, e.g. by providing an abundance of information resources, by providing simulations of real situations, and by providing tailored feedback. However, as this study shows, these new learning environments in which pupils are actively constructing knowledge, are still a rare phenomenon in education, even in the ‘technology-rich schools’ that were selected for the empirical part of this study. Although several innovative uses of ICT were reported from the classroom observations, computers are also often used as tools to ‘automate’ exercises,
or as tools to facilitate the writing of texts. The use of ICT for the gathering of information, for problem solving, simulations, etc. is employed by a minority of teachers only. In this respect, the findings of other studies, i.e. computers are used mainly to complement rather than change existing pedagogical practice, are confirmed by this study. As a consequence of this, the opportunities ICT provides to facilitate differentiation, in many cases remain unused.

To prevent ICT from just being integrated into traditional teaching practice, optimal education should be promoted. In this respect, ICT may play a supporting role. Meeting the following five guidelines is crucial with regard to optimizing educational practice:

1) Active, autonomous learning should be fostered by relevant pedagogical and social aspects. Pedagogically, the educational situation should promote the harmonious growth and stimulation of every learner on all relevant aspects. Pupils should be given more social and didactic responsibilities.

2) Educational content should be based on each pupil’s entry characteristics or entrance level. Relevant behaviours and differences in developmental functioning of the pupils in a class should be used as basics to part of the didactic learning characteristics in the class.

3) Within the educational content, non-structured as well as structured contents should be distinguished. For children developing slowly, the materials should refer to remedial activities. For children gifted in a certain aspect, the didactic materials should be situated on a much higher level, requiring more self-regulation and cooperation in small groups.

4) The pupils’ progress with regard to cognitive as well as social aspects should be assessed regularly, in order to discover whether the provision of learning content should be altered. Quality indicators are necessary to evaluate or judge educational processes and their outcomes on every learner, from the beginning in kindergarten onwards.

5) Characteristics of the educational content should be evaluated with respect to their contribution to the pupils’ progress on a regular basis.

Recommendations

Teachers’ beliefs and skills with regard to the use of ICT in education should be enhanced by focusing on educational uses of ICT in teacher training, by stimulating communication with colleagues, by providing access to ICT in properly equipped practice
rooms for teachers in the schools, by stimulating the presence of ICT equipment at the teachers’ homes, and by providing teachers with information about educational software.

Sufficient access to ICT equipment for pupils is another crucial precondition for the use of ICT in classroom practice. If the equipment is situated in a computer room, there should be sufficient opportunities for teachers to schedule lessons in that room. Apart from this, enhancing active and autonomous learning requires that pupils have access to properly equipped individual places for study inside and outside the classroom, during as well as after lessons. There has to be enough space for ICT-related activities for pupils in the school building. Teachers should be supported by an ICT co-ordinator and a system operator. The school management should allocate budgets for the purchase of educational software. There has to be sufficient and adequate educational software available, and teachers should be informed about the range of products.

The use of ICT by teachers should be stimulated by the school management, e.g. by encouraging teachers to attend relevant training, by imposing the use of ICT for keeping records of achievement, or by introducing pupil monitoring systems that use ICT. Adding certain ICT-related activities to the curriculum as well as adding certain skills with regard to the use of ICT to the examination requirements will stimulate the development of adequate educational software as well as the use of ICT in educational practice.

Finally, optimal education should be realized according to the five guidelines given above. ICT may play a supporting role with regard to all these guidelines, if the potential of ICT (e.g. with regard to fostering differentiation) is utilized. Optimal education fits the needs of every individual pupil, instead of focussing at the ‘average’ pupil. As a result of this, pupils are stimulated to work more independently and more actively than is the case in traditional approaches.
1 Introduction

1.1 Information and Communication Technology in education

In society, Information and Communication Technology (ICT) plays a crucial role, and it is still becoming more important. New technologies are essential tools for doing business, and are quickly becoming a primary means for people to acquire information, as the American Office of Technology Assessment states (OTA, 1995). This means that ‘For students, the ability to use technology has come to be recognized as an indispensable skill.’ (ibid., p. 4). Nevertheless, the OTA studies revealed that a substantial number of teachers in the United States of America make little or no use of computers for instruction, despite the (increasing) availability of computers in the schools. From data gathered (in 1989) within the framework of the IEA study of computer use in education in Europe (Pelgrum & Plomp, 1993), the conclusion is drawn that computer use is limited in many European countries as well.

The European Commission has adopted an action plan, ‘Learning in the Information Society’, in order to speed up the process of implementing ICT in education. This plan focusses on primary and secondary education, because that is where, according to the authors, ‘the need for technology is being met least satisfactorily’ (European Commission, 1996a, p.2). In the action plan, four action lines are proposed:
1) the encouraging of the interconnection of regional and national school networks at a Community level;
2) the stimulating of the development and dissemination of educational content of European interest;
3) the promotion of training and support for teachers and trainers;
4) the providing of information on educational opportunities afforded by audiovisual equipment and multimedia products.

These actions may be carried out within the framework of Community resources from the programmes concerned with ‘content’ development (Media 2, Info 2000), education and training (Socrates, Leonardo da Vinci), and research (telematics applications, information technologies, socio-economic research). Additionally, permanent partnerships between the public and private sectors will be promoted, in order to equip and link up schools. Finally, general goodwill will be encouraged through publicity events in conjunction with schools, multimedia firms and network operators.
1.2 From an innovation-oriented to a teacher-oriented approach

Veen (1994) describes the development during the eighties from an innovation-oriented to a teacher-oriented approach in the process of integrating computer use in the classroom. Around 1980, ‘computer literacy’ was considered to be of great importance. Students were supposed to learn how to program the computer, in order to acquire higher thinking skills (see e.g. Papert, 1980). In the mid-eighties, the view of the computer as a teachers’ tool gained interest. In this view, teachers are expected to develop their own educational programs by using ‘content-free software’ (see Dede, 1984). At the end of the eighties, the idea emerged that developing educational materials should not be assigned to teachers, but to expert developers. At first the role of the teacher in the process of integrating computers in education was neglected. Innovators focussed on the computer and often considered the teacher to be a barrier which had to be overcome. According to Veen, several innovators looked upon teachers as executors of prescribed tasks, implying that detailed tasks had to be formulated in order to get teachers to use computers in the classroom. Slowly, there has been a shift from technology-centred to teacher-centred thinking in the second half of the eighties. More and more, the teacher is looked upon as the crucial factor in the innovation process.

Until now, only few studies focussed on the impact of ICT on the teacher. Research has primarily addressed the implications of learning with ICT for students (see e.g. Watson, 1993; OTA, 1995) or the factors influencing the implementation of ICT by teachers.

1.3 From an objectivist to a constructivist view of learning

Apart from the evolution from technology-centred to teacher-centred thinking with regard to the application of ICT in education, changes in the view of how learning processes may be best fostered resulted in an evolution in educational theory from the promotion of teacher-centred learning environments to the promotion of pupil-centred learning environments.

For a long time, instructional designers made reference to theories of learning that had been developed under the behaviourist paradigm. Even with the advent of cognitive learning theories, the basic assumption of instructional designers remained that there is objective knowledge that is represented externally and that needs to be transferred into the mind of the learner, where it will be represented internally as a mental representation (see, for instance, Dick, 1991; Merrill, 1991 for a discussion of this point of view with
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respect to the development of computer programs). This objectivist point of view has recently been challenged by a more subjectivistic or constructivist point of view that holds that there is no objective, socially shared knowledge, but only subjective and individual knowledge that is constructed in each person’s mind. This, of course, is a very simplifying description of the two positions, but the basic assumption of constructivism which considers knowledge acquisition to be a process of actively constructing cognitive structures, is shared by a number of researchers in the field of instruction and computer application (Cognition and Technology Group at Vanderbilt, 1991b; Spiro et al., 1991a; 1991b).

**Behaviourism**

Within the behaviourist framework, learning is looked upon as a process that results in behaviour changes. Although the basic reinforcing mechanisms are relatively simple, Skinner demonstrated that they could be used to build highly complex behaviour (shaping). He also showed that reinforcing principles played an important role in verbal learning, and his ideas on programmed instruction influenced educational thinking and practice for some time. His ideas have not been totally abandoned - in fact, simple drill-and-practice programs that are used to learn vocabulary, for instance, are still based on his ideas, but many present-day computer programs are based on cognitive learning theories.

**Cognitive theories**

One of the basic assumptions of cognitive psychology is that knowledge is stored in long-term memory as a mental representation of the knowledge domain which the learner has studied. It is assumed that this mental representation is highly structured and that schemata act as the basic units of this cognitive structure. These building blocks of cognition (Rumelhart, 1980) play an important role in organizing the perception and storage of incoming information as well as the retrieval or reconstruction of information from long-term memory.

**Objectivism**

Merrill (1991), as an instructional designer in favour of a more objectivist point of view, assumes that knowledge exists outside the human mind. An individual’s learning activity will result in a cognitive structure which he calls a mental model. Structuring the external knowledge by organizing and elaborating it as part of the instructional process helps
students to develop an adequate mental model which later facilitates retrieval of the knowledge represented in the mental model. One of his basic assumptions is that instructional strategies are relatively independent of the knowledge to be taught. Although he talks about a mental model, he makes no claims as to how this cognitive structure might be organized. He only assumes that there is 'some correspondence' between the externally represented knowledge and its internal mental representation.

Constructivism

Recent approaches in instructional design have focussed on the problem of inert knowledge, i.e. knowledge that the students acquire without being able to make use of it. Collins has claimed that learning needs to be considered a process in which an individual actively engages, and that in general, this activity is situated in a social context, i.e. in the context of a specific culture of practitioners. In his opinion, schools have a tendency to transfer knowledge that is abstracted from the specific context which makes the knowledge thus acquired inert. Collins' approach is in accordance with the ideas of constructivism. In constructivism it is assumed that learning is a process of actively constructing knowledge as a mental representation of the outside world. This assumption is opposed to the objectivist interpretation of the metaphor of man as an information processing system. For a discussion of constructivism as related to learning theory and computer-based instruction, see Duffy & Jonassen, 1991, 1992; Dinter & Seel, 1994; Gerstenmaier & Mandl, 1995. It is assumed that this construction is a social process, i.e. it results from interaction with other people (see Vygotsky, 1978). This point of view requires instructional designers to develop learning environments that optimally assist learners to construct an adequate cognitive representation of the targeted knowledge domain. It also lends itself to the construction of learning environments that allow for collaborative learning.

Designing instructional settings

The concept of learning as the acquisition of knowledge that will be represented by an individual's cognitive structure does not necessarily imply a certain set of prescriptions for the development of instructional settings. As noted above, from an instructional designer's point of view, it is possible to take an objectivist stand - with emphasis on the instructional process of transferring externally presented knowledge into internally represented. The basic difference between objectivists and constructivists seems to be that an objectivist designer thinks of his students as information processing systems and therefore will design instructional settings that optimally feed the externally available
knowledge into these systems. A constructivist designer, on the other hand, will see his students as human beings who have self-awareness, who consciously make decisions, who think and feel, and who try to understand the world they live in. A constructivist instructional setting will therefore focus on providing a learning environment that affords a rich variety of ways to get to know specific aspects of the knowledge to be acquired. This implies, however, that learning processes and their outcomes are much more difficult to assess than in an objectivist setting.

Two examples of the constructivist approach

In recent years, two approaches to explaining learning processes as they are initiated by multimedia computer programs have evolved that are dedicated to the idea that knowledge acquisition is a process of actively constructing a mental representation in the individual’s mind. These are the anchored instruction approach as proposed by Bransford and his colleagues from the Cognition and Technology Group at Vanderbilt University (Bransford et al., 1990; Cognition and Technology Group at Vanderbilt, 1990; 1991a,b; 1993) and cognitive flexibility theory as developed by Spiro and his colleagues at the University of Illinois (Spiro & Jehng, 1990; Spiro et al., 1991a,b). One of the main differences between these approaches is that they address students at different age levels. While the anchored instruction approach is likely to work well with younger students (even at primary-school level), the cognitive flexibility approach will probably be more effective with more advanced students (at secondary-school level). Bransford, much like Collins, assumes that an adequate instructional setting is one that situates the desired learning and problem-solving processes in a specific context: ‘The major goal of anchored instruction is to overcome the inert knowledge problem. We attempt to do so by creating environments that permit sustained explorations by students and teachers and enable them to understand the kinds of problems and opportunities that experts use as tools. We also attempt to help students experience the value of exploring the same setting from multiple perspectives (e.g., as a scientist or historian).’ (Cognition and Technology Group at Vanderbilt, 1990, p. 3). According to the authors, it is necessary to anchor the knowledge that the students are supposed to acquire in a specific setting that arouses their interest. Getting students interested in the story that provides the anchor makes them more sensitive to the problems that are contained in the story, and this, in turn, motivates them to look for knowledge that they can use as a tool to solve the problem.

While there is ample evidence that the anchored instruction approach does motivate students to improve their learning and problem-solving activities (see e.g. Cognition and Technology Group at Vanderbilt, 1992), relatively little attention is paid to the cognitive
processes that are activated when students are actually acquiring knowledge in this kind of instructional setting. This aspect has been looked at more closely by Spiro and his colleagues.

The basic idea of cognitive flexibility theory as developed by Spiro is that processing complex information may not be achieved by the activation, modification and creation of complete schemata. An adequate processing of complex information requires cognitive flexibility in the sense that the student has to be able to activate partial schemata and to combine them into complex new ones. As far as the actual teaching done in schools is concerned, Spiro holds that textbook-based instruction displays severe shortcomings. In his opinion, textbooks tend to simplify problems and to offer simple solutions. These simplified solutions may, however, make it more difficult for students to understand highly complex phenomena. Referring to an image that Wittgenstein (1953) used, he compares knowledge to a landscape. In order to acquaint oneself with this landscape, one has to traverse it many times in different directions, i.e. one has to criss-cross it. Acquiring knowledge, then, means constructing a cognitive representation using different conceptual and case perspectives. From an instructional point of view, this makes it necessary to provide the learner with a flexible learning environment, and Spiro shows no sign of doubt that multimedia computer programs will make for instructional settings that serve this purpose best. There is empirical evidence that corroborates Spiro’s claims. In one of the empirical studies that Spiro conducted, a hypertext program was used to acquaint students with the social consequences of the new technology: ‘The result of this experiment revealed that while the design which emphasized the mastery of declarative knowledge led to higher performance on measures of memory for presented facts, the design based on Cognitive Flexibility Theory (which highlighted different facets of the material by explicitly demonstrating critical interrelationships between abstract and case-centred knowledge components, in multiple contexts on different passes through the same content) promoted superior transfer to new problem-solving situations.’ (Spiro et al., 1991a, p.32). In another experiment run by Jacobson & Spiro (1995), almost identical results were obtained. The experimental group that worked in a hypertext learning environment based on cognitive flexibility theory showed superior knowledge transfer, while the control group scored higher in memory for factual knowledge.
1.4 Defining the scope of this study

The goal of this project, which was requested by the European Commission, is to study the impact of ICT on the role of the teacher in primary and secondary education. Results of this study can contribute to the stimulation of ICT use in education, as intended by the European Commission. The study was conducted in five European countries: Belgium, Germany, Ireland, the Netherlands, and Spain.

The following institutes participated in this project:
- Centre for Instructional Psychology and Technology (CIP&T), University of Leuven, Belgium;
- Department of Education, University of Cologne, Germany;
- Nexus Europe Ltd., Ireland;
- Institute for Applied Social Sciences, University of Nijmegen, the Netherlands;
- Dpt. Didactica i Organitzacio Educativa, University of Barcelona, Spain.

The focus of the project is on the way ICT affects the practice of the teacher, and the way this practice may be improved. The project consists of a literature study and an empirical study. Data collection within the empirical part of the study focuses on the school level and on the teacher level. In five country reports, short descriptions are given of the conditions at the local, regional, and/or national levels which may influence ICT use in schools.

In the current study, ICT is interpreted as ‘new technology’, i.e. computers, interactive videodisc, CD-ROM, CD-I, and telematics. The use of overhead projectors, slide projectors, and videotape recorders are not part of the subject of our study. Of course the term ‘new technology’ does not refer to the age of the equipment involved, the life cycle of computers in education generally being substantially longer than in the ‘outside world’.
2 The multi-level approach

2.1 Introduction

The degree to which innovations in general and ICT in particular are implemented in education depends on several issues (Fullan, 1982, 1991; Fullan et al., 1988; Vlas & Doornekamp, 1993). Many studies have addressed the issues with regard to ICT, resulting in an extensive list of factors and actors, which may to some extent influence the implementation of ICT in the classroom (see for instance Ten Brummelhuis, 1995; Smeets, 1996a; Blom, 1997). The results of the studies as to which are the most important variables influencing ICT use in the classroom, however, are inconclusive. Moreover, there is an interaction of factors which seems to depend on the stage of the implementation process (Ten Brummelhuis, 1995; Janssen Reinen, 1996). Ten Brummelhuis (1995) distinguishes between the stages of adoption, implementation, and institutionalization of ICT, the latter stage being the most elaborate one.

Apart from this, factors and actors influencing the implementation of ICT in education may be located at various levels. The effects or impact of ICT use may also be noted at several levels, in particular at the teacher level and the pupil level. The foregoing stresses the importance of addressing several levels when studying the impact of ICT on the (role of the) teacher. Therefore, in this study a multi-level approach is adopted (see Mooij, 1987, 1992, 1993, 1997a for a theoretical explication). The following levels are being distinguished:

1) The community
   a) the national level
   b) the regional level
   c) the local level
2) The school
3) The teacher and the learning environment
4) The pupils

Relevant issues regarding the subsequent levels will be addressed in this chapter.
2.2 The community

2.2.1 Definition

Factors at the national, regional, and local level may influence the pace as well as the nature of the implementation of ICT in education. The extent of the importance of these subsequent levels varies per country. In the Netherlands, policy is centralized on the national level, making the regional and local level negligible. In Belgium, Germany, and Spain, policy with regard to ICT in education is not being made at the national level, but rather at the regional level. In Ireland, there is no regional level, whereas the local level is very important. In this study, the national, regional, and local level will be addressed as one level, ‘the community level’. The policy with regard to the implementation of ICT in education in the five countries involved in this study, will be summarized in section 2.2.4. A more detailed overview will be provided in annexes 5 to 9.

2.2.2 Factors influencing the implementation of ICT

Important factors at the community level that may stimulate the implementation of ICT in classroom practice, are financial support, courseware development, and teacher training. Another aspect which is crucial, is the position of ICT in the curriculum. These factors depend to a large extent upon the government policy towards ICT in education.

Financial support

In order to provide schools with an adequate basis for the implementation of ICT, funding is necessary. Schools have to be able to acquire suitable hardware and software. They also have to be able to provide their teachers with training, and with time to work on their professional development with regard to the use of ICT. Funding is also necessary in order to give the teachers support by a computer co-ordinator, as well as for the maintenance of hardware. The provision of hard- and software to schools may also be interpreted as financial support.

Courseware development

In order to stimulate ICT use by teachers, adequate educational software, or courseware, has to be available. Dissatisfaction with courseware is often reported to be an obstacle in the implementation of ICT in education. Keursten (1994) reviewed literature on this topic:
Some conclusions are:
- much educational software is poorly attuned to the curriculum;
- the applicability of existing courseware is often limited to a small part of the curriculum;
- much courseware has been developed for use by individual students, not taking into account the usual whole-class teaching and the practical constraints of a classroom with limited numbers of computers;
- much courseware is poorly documented: support materials for the teacher with suggestions for integrating the software in the instructional process are frequently lacking;
- much courseware does not yet sufficiently exploit the capacity of the computer to enhance teaching and learning;
- much courseware is not - or hardly - tested before publishing, resulting in uncertainty about the quality, practicality and effectiveness of the courseware.’ (Keursten, 1994, p. 172).

Several other authors also stress the importance of courseware fitting into the curriculum (Mooij, 1990; Cates, 1992; Ten Brummelhuis, 1995). The question to what extent software is produced which fits into the curriculum, is - especially in the non-English speaking countries - to a large part determined by national factors. In small countries, e.g. the Netherlands, publishers often hesitate about developing educational software, because the return on investment is considered not to be very high. This means funding by the government may be necessary to foster this process (Smeets, 1996b). In a Dutch study with regard to agricultural education, insufficient availability of software for instructional purposes was mentioned by 42 percent of the teachers participating in the survey (Blom, 1997). In Ireland, a lack of courseware in the Irish language is being reported.

Keursten concludes from his research, which focussed on teacher material in courseware packages, that teacher material may stimulate a successful implementation of courseware by suggesting solutions for implementation problems which may occur. He also concludes that teacher material may stimulate teachers to model their lectures more in accordance with the intentions of the developers of the courseware. Olson (1995), however, refers to Voogt (1993) who points out that teachers do not necessarily act in accordance with the guidelines provided by the designers of the courseware. Voogt concluded from her study that teachers didn’t use the teacher guide which came with the courseware package, but used the software according to their own planning.
Training, technical and pedagogical support

Professional development is an important issue with regard to the use of ICT in education. Hannafin and Savery (1993) conclude that fear is often cited among teachers as a reason for resisting the use of computers in the classroom: fear of losing control of ‘centre stage’, or fear of ‘looking stupid’ in front of the class. According to these authors, this fear is in many cases developed before the teachers begin teaching. This leads to the conclusion that student teachers have to be stimulated in teacher training to use ICT and to incorporate it in the right way in the learning environment. The European Commission’s Task Force Educational Software and Multimedia points out that the provision of training and information to teachers is a pre-condition for the development of pedagogic uses for multimedia (European Commission, 1996b). Professional development should not be restricted to pre-service teacher training, especially when technology use is involved. Merrill et al. (1996) state that teachers need to find a way of continually updating themselves on educational computing issues.

Position of ICT in the curriculum

The implementation of a particular innovation may be stimulated by the (national or regional) government’s decision to integrate that innovation into the curriculum, and to add it to the examination requirements (Appelhof, 1989). In the case of the integration of ICT into education, this means the use of ICT might be imposed for parts of particular subjects, and skills with regard to ICT use might be added to the examination requirements for the subjects in question.

2.2.3 ICT policy in the five countries

Belgium

In general, the policy of the Flemish government concerning ICT in education can be described as project-based. The government asks the schools to take the initiative and to subscribe for specific ICT calls for tender. It always concerns small-scale subsidies. The government prefers to support rather small initiatives in a large number of motivated schools, instead of supporting extensive projects in a small number of schools. The government requires high-quality standards of the schools that want to be engaged in an ICT project. The schools have to take the initiative, and they themselves are responsible for the project. All the projects aim in the long run at an impact on the schools which do not yet participate. The participating schools are expected to be examples of ‘best cases’
for others. As a result of this policy, there is a serious lack of equipment, as well as a lack of technical and pedagogical support, and in-service training with regard to ICT in a lot of schools in Belgium.

**Germany**

In December 1994 the Bund-Länder-Commission (Federal and State governments) for education planning and research advancement agreed on a number of guidelines concerning the use of ICT in German schools. The central demand is to employ electronic media in the classroom to a larger extent than in the past. On this basis, the Ministers of Culture and Education have declared the necessity of a clearly intensified media education. In the meantime, schools lacked the financial means to keep up with the pace of the technical development. Obviously, an improvement of this situation would overburden the budget available. By the way, most of the German literature refers to general secondary education schools; little is being said about ICT in vocational schools and in primary schools. The use of ICT in German primary schools is still an exception.

But the financial aspect is not the only problem schools have to deal with. As far as the acceptance of the ‘Information Highway’ is concerned, both Eschenauer (1996) and Weidenmann (1996) think that the main obstacle is the information monopoly the supervisory school authorities in Germany hold (i.e. the Ministers of Culture of each of the Länder and subordinate authorities at a regional level). Free access to the net might undermine the control exercised by these authorities over the subject matters that are being taught and learned at the schools. Another weak point in the implementation of ICT is the quality of the learning programs available. According to SODIS, a German data bank that describes and evaluates courseware, only 80 of 2424 programs are recommended as being suitable for school teaching (Tulodziecki et al., 1996). Moreover, the general attitude towards ICT is still characterized by a fair amount of reserve, scepticism and distrust. Disregarding the real or fictitious effects on the pupils, though, the issue on which everyone seems to agree is the inadequacy of teacher training (e.g. Perrochon & Hartmann, 1997; Horstkemper, 1997; Bruhns, 1997). The fact that teachers were not taught how to use computers for educational purposes makes it difficult for them to implement ICT in their learning environments.

Due to the fact that matters of education are regulated at the level of the ‘Länder’, schools vary from Land to Land. Furthermore, there is at least as much variation within each Land.
Ireland

For the early part of the 1990s there was no coherent policy on ICT implementation in schools. As a result of this, ICT implementation in Irish schools is undeveloped. The level of ICT penetration in schools varies considerably with some schools, particularly primary schools, being very ICT active and others remaining totally unaware of ICT. To date, ICT development in Irish schools suffers from a lack of coherent planning, fragmentation and under-resourcing. Studies by Gallagher (1995) and Gash (1996) on pre-service training provision in ICT for teachers illustrate the lack of appropriate training in ICT for student teachers. The findings show that training colleges prioritize ICT differently and that there is no minimum standard of ICT training required for teachers at pre-service level. The survey also showed that a core set of ICT skills is not being taught to student teachers. The lack of appropriate training, the lack of time, and the lack of curricular integration of ICT were identified as principal barriers by teachers participating in the Irish ‘Information Technology Integration Project’.

In April 1997 policy on ICT was for the first time seriously addressed by the Government, when it launched its new technology plan, *Schools IT 2000 Programme*. The main aim of this programme is to furnish every school with one PC (with Internet access) by the year 2000.

The Netherlands

In The Netherlands, two large scale projects were carried out in primary and secondary education, in order to stimulate the implementation of ICT use. In the latter half of the eighties, all secondary schools in The Netherlands were equipped with nine MS/DOS computers in a local area network. The production of courseware was stimulated, and in-service teacher training was provided for. In the first half of the nineties, all primary schools were equipped with (MS Windows) computers, at a rate of one computer at 60 pupils. Several software packages were included. Each school was obliged to appoint an ICT co-ordinator, and in-service training was compulsory for the school principal as well as the ICT co-ordinator in order to be equipped with computers. The ICT co-ordinators were expected to act as ‘change agents’ within the schools, informing the teachers about ICT and stimulating them to incorporate ICT in the classroom. After providing these impulses, the government adopted the policy that implementing ICT in education was the responsibility of the schools, and that teacher training and courseware development would flourish without extra financial support by the government. This expectation, however, proved to be false. In 1994, a committee that was appointed by the Dutch Ministry of Education concluded that technology was dominantly present in all sectors
The multi-level approach of society, whereas education was lagging behind (OCV, 1994). This was attributed to teachers not having the appropriate knowledge, and lacking or outdated infrastructure. In 1997, the Ministry of Education launched a new plan, ‘Investeren in Voorsprong’ ('Investing in Advancement'). Within the framework of this plan, schools were invited to make plans for incorporating ICT in education. Plans that were accepted are being funded by the government. The government is aiming at a computer-pupil ratio of 1 at 10 at the start of the next century. Schools may acquire second-hand computers from a foundation at low rates. Teacher training colleges are stimulated to incorporate ICT in pre-service teacher training and to provide tailored in-service training.

Spain

A key aspect to understand the process of introducing ICT into the schools in Spain is that there are different regional governments which have their own competences with regard to education, and which all have their own policy towards ICT. Part of the country however, falls within the jurisdiction of the central Ministry of Education and Culture (MEC).

Less than one third of the schools are private schools. However, several of these centres (the centros concertados) have an agreement with the government that covers expenses. Public centres may receive endowment in form of hardware or software, from the national or regional authorities. The private centres do not. However, it is usual that parents provide funds in order to acquire equipment. This means the implementation of ICT in private centres usually proceeds at a slower pace than in public centres. Finally, the ‘centros no concertados’ receive no government funding. These are in general ‘elite schools’, using ICT not only as a tool, but also in order to attract more students.

Within the framework of the Programme of New Technology of Information and Communication (PNTIC) some 3000 educational projects have been carried out within the territory of the MEC. Key activities are the distribution of computers and the training of teachers. The centralized style of PNTIC is similar to other regional programmes and it is reflected in the systematic rejection of any initiative that has not been generated or is controlled by the PNTIC. Another example is the Programme of Computers in Education (PIE) in Catalunya, a region with a high level of ICT use in education. Within this project, schools are equipped with microcomputers, peripherals and software, computer maintenance and technical support are provided, curriculum development and teacher training are being promoted, educational support is offered, educational projects in schools are co-ordinated and assessed, information, documentation and telecommunication services are established and operated, and the development and dissemination
of educational materials and IT-based projects are fostered. In a region that is less well-developed with regard to ICT use in schools, Valencia, the programme promoting ICT started just recently, and is basically restricted to the provision of hardware and teacher training. As in other regional programmes, the control over the acquisition of hardware and software is a key aspect, the initiative of teachers being reduced instead of stimulated. With respect to training, centralized courses are preferred over promoting seminars, meetings, or joint projects.

Because of the different policies reflected in different ICT promotion programmes, there are substantial contrasts between Catalunya and other regions. In Catalunya, every secondary centre has at least its own computer room, and every school has Internet access. In other regions the situation is worse. In some regions the number of pupils with access to computers is very limited.

2.3 The school

Important factors at the school level that can foster the use of ICT by teachers are school policy, access to hardware, the availability of adequate software, teacher time, internal support, and communication about ICT use.

School policy

Ten Brummelhuis (1995) distinguishes three aspects with regard to school policy in connection with ICT: whether the school will give priority to the use of computers for instruction, whether the school prescribes which hard- and software will be used, and whether all students have to acquire some experience with computers. Apart from this, school policy may regard the selection and provision of teacher training, the allocation of budgets, communication about ICT use, the provision of internal support, and prescriptions with regard to the use of ICT for management purposes.

Access to hardware

Obviously, the availability of hardware is a 'conditio sine qua non' for the use of ICT in education. However, just the availability is not enough. From studies in the USA the conclusion is drawn that increased availability and support for computers does not mean a large-scale integration of computers into the teaching process (Marcinkiewicz, 1996).
As is stated in the OTA report on teachers and technology (OTA, 1995), it is not just the number of computers available that is important. Other factors with regard to the access to hardware are relevant as well. These are questions concerning the type of technology, connectivity, and the age of the equipment, as well as organizational arrangements. Organizational arrangements address the placement and flexibility of the equipment. Implementing technology in education calls for extra space in classrooms, individual places for study and/or computer rooms. Historically, the computer room has been the most common response to the use of the computer for teaching (Stuebing, 1994). In this way, all pupils have access to the technology, and full-group instruction is possible. Disadvantages of this approach are the necessity of scheduling class time in the computer room and the emphasis which is put on the use of computers. Computer rooms are common practice in secondary schools (cf. Barchechath et al., 1998). According to Watson (1990), the location of computers in a computer room may be a barrier for integration of ICT in education. In her opinion, computers ought to be available in the classroom, as tools amongst others, giving teachers a better access to the equipment. Handler (1990) concluded from a study that the availability of computers in the classroom promoted the implementation of ICT use stronger than the availability of computers in a separate computer room. Examples of schools which integrate computers in the classroom are generally found at primary-school level (Stuebing, 1994). In these cases, the number of computers usually is limited to one or two, which puts restraints on the opportunity to integrate computer use in the educational process. The number of computers which may be integrated into the classroom is not only being limited by the available budget, but also by the amount of space which is available.

Access to technology is not just relevant with regard to the use of technology in the educational process, but also with regard to the opportunity for the teachers’ professional development. In order to enhance their professional development, teachers need dedicated and properly equipped practice and study rooms in which to prepare learning materials and in order to get acquainted with new applications (Stuebing, 1994).

The availability of adequate software

As stated in section 2.2.2, the availability of software which fits into the curriculum is to a large part determined by factors at the community level. However, the purchase of suitable software that is available on the market depends on school policy with regard to the acquisition of software and to the attribution of financial resources for the purchase of courseware.
Teacher time

Time is a crucial factor with regard to the implementation of ICT in education. In the OTA report, it is stated that: ‘Probably the greatest barrier to technology use, however, is simply lack of teacher time - time to attend training or workshops, to experiment with machines and explore software, to talk to other teachers about what works and what doesn’t, and to plan lessons using new materials or methods.’ (OTA, 1995, p. 25). In a study with regard to factors influencing the use of ICT by teachers in Dutch agricultural education (Blom, 1997), insufficient time to develop lessons in which computers are used was mentioned by 59 percent of the teachers as a problem connected with the use of computers. Maddin (1997) states: ‘Time is one of the most critical factors in adopting any new initiative. Time to learn, time to practice, time to reflect. After-school workshops provide neither the time nor the context in which to effectively examine the impact of technology on learning. Short-term training, even when conducted intensely during summer months or intersession, cannot, by itself, produce change. Training must be accompanied by a well-designed maintenance plan that provides opportunities for teachers to talk about their issues, ask questions, and get feedback. By viewing the adoption of technology as a process that takes place gradually, schools can provide both the time and the resources to help teachers implement technology effectively’ (p. 59). How much time there is for teachers to familiarize themselves with ICT, depends on decisions made at the community level, choices made at the school level and choices made by the teachers themselves.

Internal support

Support from the school principal may stimulate the implementation of ICT in education (Fullan et al., 1988; Janssen Reinen, 1996). Marcinkiewicz (1996) points out that ‘In order for teachers to adopt computers, there needs to be a perception generated by the professional environment that computer integration is expected.’ (p. 471). One of the findings of the IEA study of computers in education is that school principals generally have favourable attitudes towards the use of computers in education (Pelgrum & Plomp, 1993).

In response to a gap in existing literature, Morgan’s research (1995) addressed the management activities, aspirations and attitudes of persons in charge of computing in Ireland. These persons are referred to as the terms IT co-ordinators. He believes that the emerging role of IT co-ordinator is central to the development of computers in education. However, in his survey Morgan found that a majority of the co-ordinators were not compensated for the work they do in terms of money or time off. A Dutch study of ICT
use in primary education showed that support from the school’s computer co-ordinator is even more important than support from the school principal (Van Zoelen et al., 1994). Teachers who were satisfied with their computer co-ordinator, were found to make more use of ICT and to encounter less problems with ICT in their lessons. Other studies also stress the influence of the computer co-ordinator (Janssen Reinen, 1996). A survey among ICT co-ordinators in secondary education (Renema & Smeets, 1992) showed that these staff members play an important role in the decision-making process with regard to the acquisition of courseware. Another important task of the ICT co-ordinator is to provide the teachers with information about courseware packages. Often teachers do not have sufficient information about the availability of courseware for their subjects (Timmer, 1991).

The technical assistance, including the installation and maintenance of hard- and software, may be part of the task of the ICT co-ordinator, but it may also be in the hands of a system operator (Smeets, 1988). In some cases, system operators may also assist teachers in the classroom during ICT use. The latter task may also be carried out by teaching assistants.

Communication

Interaction with colleagues as well as the school principal and the computer co-ordinator about the innovation may foster the implementation of ICT in education. Lack of communication within the school may prove to be a major barrier to technology use (Janssen Reinen, 1996). Richardson (1997) states: ‘IT-competent teachers list professional dialogue as being one of the major factors that enabled them to evolve towards a new style of teaching.’ (op. cit. p. 118).

2.4 The teacher and the learning environment

2.4.1 Introduction

Optimal learning processes cannot be obtained unless there is an optimal learning environment. The teacher plays a crucial role in modelling and managing the learning environment, including making decisions about whether and how to incorporate ICT. In the following subsections, attention will be paid to the factors influencing the use of ICT by teachers, the way teachers are modelling and managing the learning environment in which ICT is used, the teacher’s professional development, the impact of using ICT on the teacher’s role, and task perception.
2.4.2 Factors influencing the use of ICT by teachers

Teacher factors play an important role in the implementation of ICT in educational practice. Veen (1994, 1995) concluded from his dissertation study that teacher factors outweigh the school factors in explaining the teachers' uses of computers. He groups these teacher-level factors into two subcategories: beliefs and skills.

Teachers' beliefs

Teachers' beliefs are crucial to the implementation of ICT in the classroom. Teachers have to see the advantages of the proposed innovation and they have to be motivated to implement the innovation in their teaching practice. According to Ten Brummelhuis (1995), who studied the factors influencing ICT use by teachers during the adoption as well as during the implementation stage, the perceived relevance of the innovation is the one factor which is significantly influencing ICT use by teachers at both stages. In short, they have to believe the innovation will 'work' (OTA, 1995): 'First and foremost, teachers want to ensure that their students are learning. If technology can be a resource to enhance student achievement and interest in learning, teachers are more likely to invest the time and energy to learn to use it in their teaching.' (p. 8). However, the OTA report points out that the relationship between technology and student learning is too often framed as a seemingly simple question: 'is teaching with computers and other technologies better than teaching without them?' (ibid.). According to Eraut (1991), teachers often doubt that pupils will substantially benefit from innovations. It is evidenced in the recent past that a mere technology-driven approach of learning, no matter how attractive ICT devices may be, leads towards disappointing results (see Clark & Sugrue, 1990). Moreover, no direct influence of technological environments on learning outcomes may be postulated. Learning effects are mediated by both teachers and students (see Lowyck & Elen, 1994).

According to Veen (1994, 1995), teachers' beliefs regarding what should be in the curricula and the way in which the subject should be taught, play an important role in deciding whether or not to use ICT in the classroom. Apart from this, teachers have beliefs about their roles in the classroom and about corresponding classroom activities, personal views on education, and views on their own functioning as teachers. These beliefs influence their use of computers. The author states that teachers will adopt new media if they can use them in accordance with their existing beliefs and practice.

According to Duffy and Jonassen (1991), teachers may adapt learning environments according to their beliefs about the value of the (goals of the) proposed innovation, and
their beliefs about learning. This means they will try to supplement or replace content and strategies with approaches they feel will lead to the ‘appropriate’ understanding of the subject matter by pupils. This may be incompatible with the intentions of the designers of ICT courseware used in the learning environment. Several authors stress that the practices and beliefs of teachers should be taken into account by educational technologists (Lowther & Sullivan, 1994). In general, however, little is known about the beliefs of teachers with regard to the pupils’ learning. Some light into this matter is shed by Hannafin and Freeman (1995). They conclude, based on research, that more experienced teachers have less confidence in the pupils’ skills to manage their own learning. This may lead to a more negative attitude of these teachers towards pupil-centred learning environments, which - theoretically - are often connected to the use of ICT in education. Lowther and Sullivan (1994) studied (K-8 and grades 9-12) teachers’ beliefs about educational technology. They conclude that both groups showed general agreement with statements in favour of giving pupils more control over the learning process. However, teachers of younger pupils (K-8) had more confidence in their pupils’ ability to select appropriate learning objectives and strategies for themselves than teachers of pupils in the grades 9-12. The study also yielded a moderate agreement with positive statements concerning co-operative learning, which is also interrelated to ICT use in the classroom (see section 2.4). At this point there also was a noticeable difference in opinions between both teacher groups, with the K-8 teachers being much more in favour of co-operative learning (see also Van den Eeden et al., 1993; Terwel & Mooij, 1995).

Olson (1988) also concludes from a case-study research that an innovation like the introduction of computers in the classroom is determined by personal factors and individual characteristics of the teachers involved. A consequence of this finding is, according to Olson, that a thorough understanding of the ideas and actions of teachers is essential in order to be able to determine the possibilities of computer use in the classroom. During the fourth German-American Dialogue in 1996, concerning the topic ‘Media literacy as challenge to schools and education’ (initially opened by the Bertelsmann Stiftung in 1992), positive and negative expectations teachers have about the application of media in the classroom were listed (Eschenauer, 1996). Some of the teachers’ fears were:
- to eventually become obsolete, to be replaced by a computer;
- to lose authority, credibility, control;
- to be put under pressure by constantly having to keep informed about the newest developments of programs which would require additional work to be done in their spare time;
- to experience ‘techno-stress’ or even ‘techno-breakdown’ during lessons;
- to be flooded with information;
- to witness the loss of cultural values and authentic experience;
- to be exposed to undesirable values;
- to see the gap between social groups grow wider.

The positive expectations usually regarded the quality of lessons and the facilitation of work. Teachers seem to expect more freedom in the organization of the lessons and in the teaching methods. They hope that quick and easy access to information offered on the Web will help them plan their lessons, and on a more general level will also allow teachers as well as students to broaden their horizon and to make contact with different cultures. The fact of saving time is therefore considered as important as the learning potential in using ICT. Teachers welcome the possibilities of explanation, presentation and visualization that computer-aided instruction yields because they hope that lessons will become more interesting to pupils. Furthermore, according to teachers’ expectations, communication with parents and colleagues and co-operation with authorities and institutions will be facilitated, in-service training and self-instruction on the teachers’ part will be easily organized, and even curricula will be developed and updated with less difficulty. As far as the pupils are concerned, according to Eschenauer’s study, teachers expect them to show more motivation in an ICT-enriched learning environment and to be more willing to prepare for the lessons at home. The work in class may be supported more actively and pupils’ progress and success can be more easily observed. On the whole, teachers hope to become more professional and to improve their image.

**Teachers’ skills**

The skills of teachers that most influence their uses of computers are, according to Veen’s study, those skills related to their competence in classroom management activities, to their pedagogical skills and, less importantly, to their computer-handling technical skills (Veen, 1994, 1995). A survey by Gash (1996) of student teachers’ views on their training on ICT in Ireland showed the main constraint in using ICT in the classroom was their lack of confidence and knowledge about the new technologies. In a study by the Irish National Teachers’ Organisation (1994) 432 teachers’ views on in-service education were surveyed. When teachers were asked to prioritize study areas in in-service provision they would like provided at local level, the highest percentage of first preferences (54%) was in computer technology. In Blom’s study of ICT in Dutch agricultural education (Blom, 1997), the teachers’ lack of knowledge and skills were mentioned as a barrier to ICT use by 38 percent of the teachers surveyed. This study showed that a large group of teachers was eager to expand their present knowledge about and skills with regard to the use of computers for teaching and learning.
Keeler (1996) points at the fact that there is often a considerable difference between the attitudes of students and the attitudes of teachers towards computers, the former holding more favourable attitudes. Keeler emphasizes that a teacher's adjustment to the use of technology requires considerable effort, new knowledge, and a willingness to change existing teaching strategies. Many (elementary-school) teachers feel that their students are more computer literate than they are themselves. Richardson (1997) reports from a classroom where the teacher even gets help from pupils if there are technical problems.

2.4.3 Modelling and managing the learning environment

Although the prescriptions made by the curriculum and the availability of resources are important factors influencing the learning environment, the influence of the teacher is crucial. Though during a lasting period the task of teachers has been described in terms of teaching behaviours, the increasing complexity of the classroom setting gradually shifted attention towards the classroom environment and concomitant management behaviours. Duke (1979) refers to classroom management as 'the provisions and procedures necessary to establish and maintain an environment in which instruction and learning can occur' (p. xii). It is the task of teachers to create a suitable (learning) environment for individuals and groups in order to guarantee the necessary conditions for learning. The complexity of that environment calls for adequate teacher behaviours in order to cope with different management aspects, like the optimal relationship between teachers and students, skills in effective planning and organization of instruction, and skills in organizing and leading the classroom as a group.

Teachers fulfill numerous tasks with respect to modelling and managing the learning environment:
- selecting goals
- selecting content
- selecting media
- selecting learning materials (including courseware)
- selecting teaching methods
- grouping pupils
- allocating time for the activities to be performed
- enabling differentiation
- interacting with pupils
- monitoring pupils' progress
- assessing the learning effects.
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The use of ICT may influence the learning environment in terms of infrastructure, classroom structure, grouping, learning tasks, interaction patterns, behavioural control, mental effort, interaction, time schedule, teaching and learning methods, etc. The nature of this influence is to a large part determined by the teacher.

In the following text, several aspects of the learning environment, as well as the teachers’ actions are elaborated.

**Goals**

Contrary to earlier definitions, where tasks are defined by instructional agents who can perfectly control the type, quality and content of tasks, the new concept of task refers to a more open activity structure that has to be filled in by constructive learners. Tasks are no more perceived as part of a fixed programme or a mastery learning context, but as constructs that need to be built, resulting from decisions shared by instructional agents and learners. The transition from a subject-matter-oriented model towards a cognitive model appears in the development of learning tasks that stimulate cognitive activity in pupils. As Doyle (1986) contends: ‘Tasks regulate the selection of information and the choice for processing that information... Students will learn what a task leads them to do, that is, they will acquire information and operations that are necessary to accomplish the tasks they encounter.’ In open-ended, pupil-centred learning environments, goal setting changes. The pupil decides to a large extent what, when, and how learning will occur and so has a central position (Hannafin et al., 1994).

**Media and content**

For a long time, text books were the only learning materials available in the classroom, whereas chalk, black board and maps were the only tools supporting the teacher. The introduction of audiovisual equipment, the overhead projector, and eventually the computer, including courseware, in the classroom enlarged the collection of media and learning materials available.

In traditional classrooms, students have more or less the same opportunity to learn the same content, since they are taught in a classroom setting with a well-defined number of hours spent on each course, the same curriculum with some differentiation opportunities, and the same homework assignments. If, however, the fixed curricular content is replaced by more flexible, open and divergent knowledge resources, the opportunity to learn holds another connotation. Instead of focusing on a fixed amount and type of subject-matter as the object of any learning process, it is rather the cognitive and
metacognitive strategies that are aimed at Opportunity to learn is no more merely defined by a limited and well-structured, content-driven and ‘container’ knowledge, but by an open, strategy-driven, and ‘knowledge landscape’ metaphor (see Lowyck, 1993). It is clear that organizing knowledge acquisition in these open environments calls for more precise knowledge management strategies from the part of the teacher or tutor. Moreover, the whole classroom organization has to be adapted. ICT may support this process in several ways, by (1) providing opportunities for adapting the learning content to the individual pupil’s needs, and (2) serving as a management tool for the teacher, classifying the materials available, administering tasks to pupils, and recording the pupils’ achievements.

Eventually, being able to provide education which is tailored to the individual pupil’s needs, may lead to the abolishing of the year group system, enabling pupils to develop various skills at various pace.

With regard to ICT use in educational practice, several classifications are utilized. Squires and McDougall (1994) provide an extensive overview. A well-known classification was suggested by Taylor (1980) (see also Merrill et al., 1996), who focusses on the educational role the software may play. He distinguishes between three application types: a) tutor applications (the computer acts as a tutor by performing a teaching role); b) tool applications (the computer serves as a tool, e.g. word processing, databases); c) tutee applications (the user has to teach the computer to do a task, by programming it).

Within the category of tutor applications, a distinction may be made between more objectivist, teacher-centred applications (drill-and-practice, tutorials) and more constructivist, pupil-centred applications (simulations, problem-solving applications, games / adventures).

A framework for the classification of educational software which is still one of the most respected, was developed over twenty years ago by Kemmis et al. (1977) (see also Watson, 1987; Squires & McDougall, 1994; Collins et al., 1997). They list four paradigms of learning associated with ICT: 1) the instructional paradigm; 2) the revelatory paradigm; 3) the conjectural paradigm; 4) the emancipatory paradigm.
The overall aim of the *instructional paradigm* is to provide the learner with structured subject content broken down into small parts which may all be processed independently. This paradigm is drawn from ideas of programmed learning, based on behaviourist views of learning. The use of ICT in this case provides the advantage of immediate (but limited) feedback. Drill and practice exercises are a widespread example of this kind of structured software. Within the framework of the *revelatory paradigm*, the learner is guided through a process of learning by discovery, the subject matter and the underlying theory gradually being revealed as the learner uses the computer program. Simulations are a good example of this way of interacting with ICT. The *conjectural paradigm* involves more control of the learner over the computer. Students are encouraged to formulate hypotheses, test and manipulate these. Thus, students learn by experimentation and exploration. Finally, the *emancipatory paradigm* involves the use of ICT as a labour-saving device or a tool (e.g. for word processing, drawing graphs, or making calculations).

Moving from the instructional towards the conjectural paradigm, there is an increase in learner control, and a decrease in ‘program control’. The emancipatory paradigm does not exactly fit into this range. According to Watson (1987), this paradigm may often appear in parallel with other paradigms. Moving towards pupil-centred ICT learning environments requires a ‘paradigm shift’, in order to move away from the focus on ICT applications which are designed in accordance with the instructional paradigm. Whether this paradigm shift occurs, depends on the teacher, who decides on the type of software to be used as well as the amount of structure that will be provided to the learners.

Apart from the application in the classroom, ICT may also be of use to teachers when they are selecting content to be presented in their lessons, e.g. by providing access to online databases, CD-ROMs, videodiscs and other electronic sources which help teachers to create, customize, and update lessons (OTA, 1995). At this point, of course, access to the Internet may also be considered important. Another example of ICT enhancing the teachers’ activities outside the classroom, is the use of ICT as a tool (cf. Merrill et al., 1996), e.g. the use of software packages for word processing, databases and spreadsheets.

*Teaching methods*

The introduction of ICT in the classroom may lead to a shift in teaching methods, the most notable being the increases in small-group work or co-operative learning, and in pupil-centred discussion. Barchechath et al. (1998) conclude from a study of the use of ICT in educational practice that it is a general practice that using ICT implies a challenge
to traditional whole-class teaching. The rise of individualized learning and co-operative learning necessitated specific teachers’ skills in terms of individual management and group management. Moreover, the increased use of technology reveals a new but complex challenge to the skills of teachers.

At the micro level, teachers are faced with many types of decisions and are required to fulfill many different tasks related to the daily use of ICT (decisions about when pupils should use computers, how to link their use with other instructional activities, which software to use, how to co-ordinate use of computers among different classes and among pupils within a classroom, etc.). These new tasks require observational and management skills different from those that teachers usually apply.

Pisapia (1994a) concludes from a review of practices of teachers who use educational technology that in exemplary classrooms student use of learning technologies is woven integrally into the patterns of teaching, even though technology-using teachers can use resources in different ways, such as drill and practice exercises, simulations, problem-solving activities, and productivity tools.

Apart from the classifications of ICT use mentioned above, ICT-related activities in the classroom may also be categorized as a result of a combination of the equipment, the teaching method and the grouping of pupils. Thus, Veen (1994) distinguishes between seven types of ‘computer supported learning environments’ in the classroom. The following list is a partly simplified and partly enhanced derivation of Veen’s classification:

1) ‘The computer as an electronic blackboard’. One computer is used, which is operated by the teacher. The results of the teachers’ actions are projected on a large screen. This application is connected to whole-class teaching.

2) ‘Working apart together’. Pupils work individually, in pairs or in small groups during a substantial period of time at a limited number of computers. The rest of the class is being taught by the teacher, or is also working individually, in pairs or in small groups.

3) ‘Rotating computer use’. Pupils work individually, in pairs or in small groups for a short period of time at a limited number of computers. The rest of the class is being taught by the teacher, or is also working individually, in pairs or in small groups. Computer use rotates at a regular basis.

4) ‘Individual or group work’. All pupils are working individually, in pairs, or in small groups at the computer. The teacher acts as a coach.
Interaction / feedback

When all pupils are working autonomously, it may be difficult for teachers to provide help for all or even for most of the problems that their pupils face. Therefore, the teacher has to integrate the following conflicting teaching methods: the frontal teaching (identical for the whole class) with the individualized instruction (different instruction for each student), and group instruction as a mix of classroom and individual components. By an appropriate use of questions, assertions, observations, etc. the teacher can respond to the needs of the individual pupil at a personal level: such responses are rarely possible in whole-class teaching. Direct interaction allows the teacher to gain insight into the problems faced by the pupil, and offers the pupil an opportunity to check and/or develop his own understanding of the topic. The nature of the questions used by the teacher also appears to undergo a significant change when ICT is in use. Or as Chatterton (1985) says: ‘There appears to be a much greater willingness on the part of the teacher to use questions which are more open-ended and which also place a greater intellectual demand on the pupil. The reason may not lie in the structure of the programs themselves but could be a reflection of the changes in classroom organization or teaching style which become apparent when the micro is used.’ (p. 94).

Feedback in pupil-centred learning environments may be characterized as guidance and facilitation. Guidance and facilitation focus on supporting the effective use of the properties of the learning environment. Guidance, on the one hand, means assisting the learner in coping with the learning environment through suggested learning strategies, help options, procedural advice, hints and prompts. Facilitation, on the other hand, emphasizes the empowerment of the individual in deploying his or her own cognitive strategies (Hannafin et al., 1994).

Evaluation

Monitoring pupils’ achievements or tracking student progress (OTA, 1995) is another task of the teacher which may be assisted by the use of technology. Particularly grade book programs and pupil monitoring systems are of use here. Keeler (1996) concludes from her study in primary schools, that teachers using ICT generally felt more informed about their pupils’ performance, since the computer took over part of the management by recording progress.
2.4.4 The teacher's role in the ICT learning environment

Hannafin and Savenye (1993) point out that the teachers’ role in the classroom can be viewed as a continuum. At the one end is the teacher as a traditional lecturer and impart-er of knowledge. This is in accordance with objectivist views of learning. At the other end is the teacher as a coach, observer, and facilitator. This fits into the constructivist view of learning. Teaching in pupil-centred learning environments requires a different attitude of the teacher from teaching in traditional instructional settings: ‘Teachers will need to move from providing face-to-face teaching and text-based learning to facilitating individualized, interactive, media-based learning, and learners will need to be empowered to accept far greater responsibility for their own learning.’ (Latchem et al., 1993, p. 28). Brown, Collins and Duguid (1989) suggest the cognitive apprenticeship approach. This means the teacher stimulates the pupils to solve problems by ways of modelling, coaching and scaffolding. Modelling refers to the teacher showing the pupils how to carry out a certain task. Coaching means the teacher is providing feedback while the pupils are carrying out the task. Scaffolding is providing cognitive support with regard to a task the pupils cannot carry out themselves. In a social interaction process among pupils and between the pupils and the teacher, pupils gather knowledge in an active manner. The teacher must not be too supportive, because this forces the pupils into a passive, receptive role. As the pupils show they can perform the respective task independently, the teacher’s support gradually vanishes (‘fading’). The gradual shift from teacher-centred learning to pupil-centred learning is time-consuming and requires skilful teachers (Verschaffel, 1995).

Davis and Shade (1994) describe several roles teachers fill when they are helping children to learn in computer-enriched classrooms. Initially, they serve as instructors to children in the use of computers. Later, as children gain more experience, the teacher’s role moves to that of a coach. By using computers themselves, teachers can also serve as models to children. Finally, teachers must be critics of computer software, learning to select the best software to enhance children’s development.

Hannafin and Savenye (1993) point out that the teachers’ role does not change simply by using the computer in the classroom: ‘The change occurs only to the extent to which a shift of responsibility to the learners occurs. The more responsibility and freedom is given to the learners, the greater the shift in the teachers’ role’ (p. 28).

In a study of the use of multimedia in a Dutch secondary school (Smeets, 1996a; Smeets & Mooij, 1996, 1997, 1999), four multimedia learning environments were implemented in geography education. There was a gradual shift from a structured learning environ-
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ment, in which pupils were being instructed step by step, to an open-ended learning environment, in which pupils were expected to conduct a small scale research. After the experiment ended, the teachers kept working with these learning environments. However, they skipped some elements of the open-ended learning environments (e.g. a role-play), and added more instructions.

Hassell (1983) states that teachers find it very difficult, if not impossible, to change their teaching style, which Hassell considers necessary when incorporating ICT in educational practice. Duchâteau (1995), on the other hand, believes that many computer uses force the teacher to revise his or her role and to modify attitudes. In connection with this, he talks about the teacher as ‘a cartographer drawing maps for exploring ‘knowledge lands’’ (p. 25). According to Hannafin and Savenye, the shift in the teachers’ role, then, may coincide with an underlying change in learning theory, which not all teachers are ready to make. The intended shift may also refer to educational goals (learning to learn / fostering metacognitive knowledge), knowledge structure (no ‘container knowledge’, but ‘knowledge landscapes’), and technology (nonlinear, open, multimedia, networked). This synergy between all dimensions at all levels (micro, meso, and macro levels) is the basic condition for avoiding the myth of Sisyphus labour (see Lowyck, 1993), which refers to the fact that each technological ‘breakthrough’ in the past often resulted in disappointment followed by disillusionment and eventually abandonment (see Lowyck & De Corte, 1986). Figure 2.1 gives an overview of some aspects of the continuum which is outlined in the preceding.

**Figure 2.1 - From teacher-centred to pupil-centred teaching and learning: a continuum**

<table>
<thead>
<tr>
<th>Objectivist theory of learning</th>
<th>Constructivist theory of learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher-centred</td>
<td>Pupil-centred</td>
</tr>
<tr>
<td>Teacher transfers knowledge</td>
<td>Pupils construct knowledge</td>
</tr>
<tr>
<td>Teacher as a lecturer</td>
<td>Teacher as a coach</td>
</tr>
<tr>
<td>Teacher in control</td>
<td>Pupils in control</td>
</tr>
<tr>
<td>Focus on whole-class teaching</td>
<td>Focus on collaborative learning</td>
</tr>
</tbody>
</table>

In assessments of ICT projects in education, teachers indeed often report a shift in their role, from the central manager of the learning process towards a facilitator or coach. Schofield (1995) states that the most commonly shared theme among studies of the impact of classroom computer use on teachers’ roles is that in one way or another the
classroom becomes less teacher-centred. She refers to Bracey (1988), who concluded that teachers using computers in their classrooms increasingly see themselves as facilitators of learning rather than as ‘authority figures whose job it is to impart knowledge didactically’. Keeler (1996) reports changes in teaching strategies as a result of the use of ICT in primary schools. The implementation of ICT resulted in the use of ‘centres for learning’, which allowed the pupils to discover knowledge for themselves, working in small groups. Teachers noted a switch from teacher-centred to student-centred instruction, resulting in the learners becoming more self-motivated and more active. Barchechath et al. (1998) conclude that the teacher’s role shifts from a directive-prescriptive to a more supportive/organizational one. In a study on ICT implementation in Ireland (Gash, 1996), it was also found that teachers observed their teaching role became more like that of a ‘guide’ or ‘director’ when working with ICT.

However, some studies show that the shift in their role which is often reported by teachers, is not always noticed in the actual behaviour of the teacher in the classroom. Mellin (1987) noticed that teachers utilizing interactive videodisc in their classrooms, clearly stayed in control of the instruction process, in spite of the alleged shift towards a more pupil-centred learning environment.

Stimulating pupil-centred learning calls for pupil-centred learning environments, where ICT functions as a facilitator of active learning. Pisapia (1994b) concludes from a study of the use of ICT by educators, that teacher-centred teachers tend to use traditional instructional methods and to regard learning technologies as basic skill reinforcers, motivators, or special treats. Learner-centred teachers, on the other hand, usually choose individualized or collaborative approaches to engage students. According to Pisapia, learner-centred teachers may be high-technology users, or they may be reluctant to use technology because of personal fears and inhibitors.

One of the conclusions of the COMMITT report, which is the result of a study by a Dutch advisory committee for the Ministry of Education, is that most of the current ICT applications are used to facilitate teacher-centred arrangements of the learning process (COMMITT, 1996). This means that many applications of ICT are incorporated into existing teaching routines, instead of facilitating more pupil-centred learning. Research shows that very often the new ‘application’ tools are adapted to the teachers’ existing style. In this way, teachers teach ‘the same things in basically the same ways that they have been teaching, and then on the side they’re sticking computers in’ (Wiske cit. in Hativa, 1991, p. 642). In the report of the Impact Study (Watson, 1993), a large-scale study with regard to the use and the effects of information technology (IT) in education in the United Kingdom, it is concluded that ‘teachers using IT often considered that
computers were to be used to complement rather than change existing pedagogic practice, whether it be ‘traditional’ or ‘progressive’ (p. 160). The study of Blom (1997), with regard to ICT in Dutch agricultural education showed, amongst other things, that many teachers found it difficult to integrate computer use in their present teaching strategies. Several other authors stress the influence of existing classroom routines. Existing beliefs of teachers tend to persist during innovations, as Veen (1994) points out. Richardson (1997) found that only ‘few classes possessed the necessary means to offer pupils more than spasmodic access to IT, and that few teachers had broken away from a traditional daily routine, broken up into formal lessons slots to cover all the core subjects imposed by the curriculum.’ (op. cit. p. 72).

2.4.5 The teacher’s professional development

In the study on teachers and technology which was conducted by the Office of Technology Assessment in the United States of America (OTA, 1995), it is concluded that ICT can be of use to teachers to enhance their professional development.

As stated in section 2.3, professional dialogue is pointed out as a major factor in the teachers’ evolving towards a new style of teaching when using ICT (Richardson, 1997). This dialogue may be limited to the colleagues within the same school, but ICT provides teachers with opportunities to broaden their horizons and communicate with colleagues, as well as other experts all over the world (OTA, 1995), via the Internet. Dillemans et al. (1998) state that an adequate use of technology in human networks may contribute to the support of critical decision-making of teachers and trainers.

Training is another crucial factor in the professional development of the teacher. OTA (1995) distinguishes between ‘just-in-time’ training and support (access to new ideas, master teachers, and other experts for training and follow up), and formal courses (possibly using distance learning technologies).

2.4.6 The impact of ICT on the teacher’s task perception

The use of ICT has been reported to improve the teachers’ attitudes towards education (OTA, 1995). In a study of teachers’ views with regard to their use of ICT in educational practice in Ireland (Gash, 1996), it was found that teachers felt more motivated and effective in their work as a direct result of using ICT. In the study of the use of multimedia in a Dutch secondary school referred to above (Smeets, 1996a; Smeets &
Mooij, 1996, 1997, 1999), teachers reported an increase in job satisfaction, which they attributed to the increase of teacher-to-pupil interaction during the lessons in which multimedia were used. OTA (1995) notes the degree of satisfaction reported by teachers depends upon the characterization of the learning environment: ‘Some teachers use technology in a traditional ‘teacher-centred’ model of teaching, such as drill and practice for mastery of facts and content or as tutorials to supplement teacher-controlled activities. Other teachers use technology to support different, more student-centred approaches to instruction, in which students conduct their own scientific inquiries or projects or engage in collaborative activities, and the teacher assumes the role of facilitator or coach. The latter kinds of teachers are among the most enthusiastic technology users, since technology is particularly helpful in supporting this kind of teaching.’ (p. 49). Research findings illustrate that the response of teachers to their role of guide to autonomous learning is good. For example, in Gallagher’s study (1995) teachers were asked to evaluate the effects of ICT on their work. A majority stated that using the computer made their work more interesting while there was also strong support for the notion that the computer motivated pupils and therefore made a teacher’s job easier. Third place in the ranking was support for the proposition that pupils benefited from using ICT. A significant number of teachers also felt that ICT made their teaching more effective while a small number felt that computers made little difference to their work.

The shift towards more pupil-centred learning environments requires the teachers to create an intellectual environment in which knowledge is acquired. The teacher isn’t the all-knowing controller of activities anymore. At times he is the learner and explorer with the students (Hannafin & Savenye, 1993). For the teacher this means it is difficult to keep track of the information that is processed in ICT applications holding an abundance of data. This may, by some teachers, be seen as a threat (Mashiter 1989). Keeler (1996) points out that not all teachers are capable of admitting openly they do not have all the answers. This, according to Keeler, is a change in the role of the teacher which will be more prevalent in the future. Other research reveals that working with new technology was expected to reduce teaching effort and save teacher time, but that it simultaneously increases teaching load.

Keeler (1996) concludes from a study with regard to the implementation of ICT in primary education that the teachers involved became enthusiastic about their teaching and began to work together during weekends in order to prepare and share computer program uses. She also found that pupils were more on-task and self-managed, which required teachers less often to discipline pupils (although the active engagement of pupils
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resulted in more noise. As a result of using ICT, teachers felt they were able to spend more time with individual pupils instead of managing the whole class.

OTA (1995) found that teachers working with ICT reported they expected more of students, were more comfortable with students working independently, presented more complex materials, tailored instruction more to individual needs, adopted new roles, and spent less time lecturing.

2.4.7 Innovative impact of ICT on the teacher’s role

From the preceding, several conclusions with regard to the teacher’s role in innovative ICT learning environments may be formulated. The emphasis in these learning environments is on teachers acting as coaches, observers, and facilitators, instead of as traditional lecturers and imparters of knowledge. Since innovative learning environments are mainly pupil-centred, teachers are expected to stimulate pupils’ active, individualized as well as co-operative, learning. Teachers are expected to provide feedback which may be characterized as guidance and facilitation. Guidance means assisting the learner in coping with the learning environment by giving advice and hints instead of direct answers. Facilitation emphasizes the empowerment of the individual pupils in deploying their own cognitive strategies. As a consequence of the presence of an abundance of information in innovative ICT learning environments, the teacher is no longer able to have an overview of all the content which is available to the pupils. This means teachers have to get used to the idea that they have less control of the content their pupils may access. To compensate for this decrease in control, different forms of diagnostic or achievement tests may be used to enlarge the teacher’s and pupil’s view on the pupil’s progress.

2.4.8 Hypotheses

From the foregoing, several hypotheses may be formulated with respect to the constituents of innovative ICT learning environments, and with respect to the teacher’s role in these kinds of learning environments.

Characteristics of innovative ICT learning environments include:
1. Lesson content is adapted to the pupils’ needs and abilities;
2. Pupils are stimulated to be active learners;
3. Lesson content is situated in or referring to authentic contexts;
4. Problems may be viewed from multiple perspectives;
5. Higher order thinking skills are fostered;
6. Co-operative learning is stimulated.

With regard to the teacher’s role in innovative ICT learning environments:
7. Teachers are acting as coaches instead of as lecturers;
8. Teachers give hints and clues rather than direct answers;
9. Teachers have less control of the lesson content;
10. Teachers have more diagnostic and achievement instruments to evaluate the pupils’ progress.

2.5 The pupils

2.5.1 Relevant background variables

Prior knowledge is an important predictor of pupils’ achievements (Simons, 1995). Mooij (1990) shows that learning effects of using the computer in reading instruction are significant with both low-ability and high-ability pupils. Apart from this, some other factors are of importance at the pupil level when learning takes places with ICT. Pupils’ experience with the use of computers is the best predictor of pupils’ estimation of their own competence with regard to using the computer (Busch, 1995). Girls are often less confident about their abilities towards working with computers than boys (Shashaani, 1994), and they often have a less positive attitude towards computers than boys (Sutton, 1991; Shashaani, 1994). Part of these differences between boys and girls may be explained by the fact that girls usually have less experience with computer use than boys - which, according to Shashaani (1994), in turn might be caused by a more negative attitude towards computers.

In pupil-centred learning environments, pupils are to quite a large extent in control of the process of knowledge acquisition. Not all pupils have the ability to do this adequately. Prior knowledge (Borsook & Higginbotham-Wheat, 1991), learning styles (Simons, 1993), and metacognitive ability (Young, 1996) influence the pupils’ ability to control the learning process. The teacher has to give the pupils adequate - but not too much - support, in accordance with their abilities.
2.5.2 The impact of ICT on the pupils

As stated in section 2.4.2, the question about the value of ICT in education is too often reduced to the question whether teaching with technology is better than teaching without (OTA, 1995). This question, in turn, is often phrased as 'does teaching with technology lead to more learning achievement?'. These achievements are usually measured by tests focussing on facts (or declarative knowledge). Assessments typically consist of studies of an experimental group, using ICT, and a control group, which is being taught in a 'traditional way'. Results from studies using this 'horserace model' (Reeves, 1986, p. 102) are often inconclusive. According to Clark and Sugrue (1990), results which are in favour of the experimental treatments may often be attributed to uncontrolled effects of instructional method or content differences between the treatments, or a novelty effect which tends to appear over time.

Some recent studies conclude in favour of ICT based on other grounds than alleged learning achievement gains. For example, in the report from the Impact Study, a large scale study on ICT in education in the United Kingdom (Watson, 1993), the conclusion is drawn that ICT enhances the learning environment in numerous ways. In this study, working with computers showed an increase in the pupils' motivation, as well as the interest in the subjects involved, and it aided concentration by focussing pupils’ attention on the work at hand. Apart from this, according to the Impact Report advantages of ICT are that it provides new opportunities to work in an open-ended way, that pupils are often involved in working with ICT over quite lengthy periods, and that they often show more pride in their work. Another conclusion from the study in question is that pupils’ conceptual misunderstandings are often made more apparent through the interaction with a computing environment. In the study she conducted with regard to ICT in primary education in various countries of the European Community, Richardson (1997) made similar observations: 'Observations made during the present study consolidate the findings of the Impact Report and, in fact, lead me to believe that a sufficient number of computers in the classroom - one computer for three or four children appears to be an ideal target - can fundamentally alter organizational methods in such a way that we should no longer simply speak of learning gains, but rather of an enhanced learning environment that actively involves children. This creates a socialization process that could have far reaching effects on adaptation in the social, and eventually professional, world.' (p. 33).

Other studies stress the positive impact of ICT on the pupils’ motivation as well. Atkins and Blissett (1989), and the Cognition and Technology Group at Vanderbilt (1992) concluded that working with interactive videodiscs had a positive impact on pupils’
motivation in primary education. Smeets (1996a) concluded upon similar effects in a study of multimedia in secondary education, although significant differences between boys and girls arose at this point. In Gash’s research (1996) on the impact of ICT, teachers were asked to compare the involvement of the children in their learning prior to, and after using the new technologies of communication (NTCs), the main finding was that NTCs made children more motivated in their work.

2.6 Conclusion

The use of ICT by teachers is influenced by a set of interrelated factors. These factors are located at several levels. Key factors with regard to the question whether or not ICT will be used by teachers in their classes, as well as the question how ICT is used by these teachers, are the teachers’ beliefs and skills. Teachers will not use ICT unless they see the added value of it. Apart from this, certain facilitating conditions have to be met in order to create sufficient opportunities for the implementation of ICT in educational practice.

The impact of ICT on the teacher may be noted in changes in the way the teacher models and manages the learning environment, in changes in the teacher’s role in the learning environment, in changes in the teacher’s task perception, and in changes in the teacher’s professional development. The use of ICT in the classroom typically results in a decrease in the amount of whole-class teaching. Teachers often note a change in their role, from the teacher acting as a transferrer of knowledge to the teacher acting as a coach, guide, or facilitator of learning. However, studies show that many teachers tend to integrate ICT in existing teaching routines, instead of evolving to innovative approaches.

Figure 2.2 provides an overview of levels, factors and actors that are important in this study.
Figure 2.2 - Overview of levels, factors and actors that are relevant to ICT use in education
3 Method

3.1 Introduction

In this chapter information will be provided with regard to 25 case-studies that were carried out within the framework of this project. First, the research questions will be addressed. Subsequently, the process of selecting schools in the various countries will be described, followed by a description of the activities that were carried out within the framework of the case-studies, including an overview of the instruments, topics, and participation in the survey.

3.2 Research questions

In the empirical part of this study, the following research questions are being addressed:
1) What is the situation with regard to resources and support for teachers using ICT?
2) How is ICT actually being used by teachers?
3) What is the impact of ICT use on the teacher?
4) How may ICT use by teachers be stimulated?
5) In what respect do differences occur between primary and secondary education regarding the questions posed above?
6) In what respect do differences occur between the five countries regarding the questions posed above?

3.3 Selection of cases

Because of the small sample per country, 5 schools, the empirical part of this study cannot provide a representative view of neither ICT use nor the impact of ICT use on the teachers in primary and secondary education. In order to maximize the chances of obtaining examples of good practice with regard to ICT use, the objective was to select schools with an advanced level of ICT implementation (‘technology-rich schools’) in each country.

Belgium

Case-studies were undertaken in two primary schools and three secondary schools. The primary schools were community schools, one of them being a ‘method’ school (Freinet pedagogy). The schools were rather small: 208 and 270 pupils respectively. Both schools
had 14 teachers. The secondary schools were catholic schools. The number of pupils ranged from 400 to 770. One of these schools was a single-sex (girls) school, which is very rare in Flanders. The larger schools had 75 teachers, the smaller school 65. The names of these schools were obtained by searching the Internet and by contacting specialists in the education field.

**Germany**

Of the five schools that made up the German samples, two were at primary school level and three at secondary school level. Both primary schools were relatively small: 211 and 274 students. Both schools had 13 teachers. Students are aged 6 to 11, and both schools were near Cologne, but in more rural districts. The three schools chosen from secondary school level represented the levels of Hauptschule (HS), Realschule (RS), and Gymnasium (G), respectively. The respective numbers of students and teachers were: 459/39 (HS), 504/27 (RS) and 1200/86 (G). All three schools were near Cologne; HS was situated in a small community, RS in a part of the city of Cologne, and G in a larger community. HS in general was attended by students that did not make the superior RS and G types of education, which also accounted for a relatively high proportion (30%) of foreigners. Part of the schools were selected based on existing contacts with the University of Cologne. In addition to this, information about schools was obtained via the Internet, and from the ‘Landesinstitut für Schul- und Weiterbildung’.

**Ireland**

Case-studies were undertaken in four primary schools and one secondary school. A decision was taken to concentrate more on primary than on secondary level as there is little scope for use of ICT allowed by the curriculum at secondary level, which is very subject- and exam-orientated. In contrast, at primary level the curriculum is child-centred and typically each teacher has his or her class for the whole school year. The selection of schools was based on advice from the newly-appointed information technology officer of the Irish National Teachers Organisation.

In the four primary schools there were 2,005 pupils and 81 teachers (giving an average class size of 25 pupils). All schools were in or near Dublin. One of the primary schools was a single-sex (girls) school while all others were co-educational. One of the primary schools could be characterized as serving a fairly affluent population, two others are schools in lower-middle-class areas while the fourth school happened to be in a disadvantaged area. The secondary-level school was more recently established than the primary ones, and concerned a school where teaching is undertaken through the medium
of the Irish language. Its pupils come from middle-class families. This school had 300 pupils and 16 teachers.

The Netherlands

The case-studies in the Netherlands were conducted in three primary and two secondary schools. All schools educate boys as well as girls, which is usual in the Netherlands. The primary schools were selected from magazine articles, providing information about ICT use in the schools. Two of these three schools were at some time appointed ‘computer school of the year’ by the Dutch magazine COS (‘computers in schools’). The selection of secondary schools was based on already existing contacts with the principals of these schools.

The primary schools vary from small to large. The smallest school, which was located in the village of Blokzijl, near the ‘IJsselmeer’ lake, had 59 pupils and only 3 teachers. The second school was located in Budel, a village in the south-east of the Netherlands, near the Belgian border. This school had 159 pupils and 10 teachers. The largest of the three primary schools was located in Hilversum, in the centre of the Netherlands. There were 560 pupils and 28 teachers in the Dutch section of this school. The school also accommodated Apart from this, there is an international section, with 240 pupils and 24 teachers.

Both secondary schools were located in Nijmegen, a city of 150,000 inhabitants in the east of The Netherlands. Both were combined schools, ranging from junior vocational to pre-university education, as a result of amalgamation processes in recent years. One of these schools resulted from an amalgamation of four schools. In the second case, three schools joined forces. Both combined schools included an annexe in a village in the vicinity. School A had 1600 pupils and 150 teachers, whereas in school B the number of pupils was 1400, and the number of teachers 100.

Spain

The Spanish schools were selected from the schools participating in projects with regard to the introduction of new technology from the University of Barcelona. All schools were from the region of Catalunya, which is quite advanced with regard to ICT use in schools.

Four of the five schools were primary as well as secondary education centres, while the fifth only coached primary-school pupils. This was a small school with 8 teachers and
less than 200 children. One of the other centres also included Introductory Professional Training, which is reflected in a higher number of computers (more than 300). The number of teachers in the largest centres included as many as reaches 40, with more than one thousand pupils. Consequently, the pupils were aged from 3 years old for pre-school courses, to 18 years old, for the last secondary school courses. Only the primary centre had a limited range of 3-12 years. Every centre accepted boys and girls, which is usual in Spanish schools.

3.4 Activities and instruments

3.4.1 Interviews with school principals / ICT co-ordinators

In each school an interview was held with the school principal or with the school’s ICT co-ordinator. In the case-studies that were undertaken in Ireland, in all cases the ICT co-ordinator was interviewed together with the school principal, or separately. In the Dutch case-studies, one principal and two ICT co-ordinators from primary schools were interviewed, whereas in the two secondary schools vice-principals with responsibility for ICT were interviewed.

For these interviews, an interview guideline was developed. In the interviews, the following topics were addressed:
1) Support / resources for ICT;
2) Use of ICT in teaching;
3) Effects of using ICT in the school;
4) Obstacles to using ICT.

3.4.2 Teachers’ survey

All teachers of the schools that were selected, were invited to complete a questionnaire with regard to ICT. The topics that were addressed by the questionnaire were as follows:
1) Background variables;
2) Resources and support for ICT;
3) Characterization of the ICT learning environment;
4) ICT use outside of the classroom;
5) Impact of ICT on the pupils;
6) Impact of ICT on the teacher;
7) Barriers to (the increase of) the use of ICT.
In the Dutch part of the study, two schools objected to the questionnaire, one of them because the questionnaire was 'too much oriented towards ICT', and one because of lack of time of the teachers. In the latter school, the teachers who agreed to the classroom observations did complete a questionnaire. Table 3.1 gives an overview of the number of questionnaires administered and of the response. Almost two out of three questionnaires were completed, which may be considered a fair response rate.

Table 3.1 - Questionnaires administered and response

<table>
<thead>
<tr>
<th>Country</th>
<th>Number administered</th>
<th>Response number</th>
<th>Response percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>241</td>
<td>156</td>
<td>65%</td>
</tr>
<tr>
<td>Germany</td>
<td>115</td>
<td>65</td>
<td>57%</td>
</tr>
<tr>
<td>Ireland</td>
<td>97</td>
<td>73</td>
<td>75%</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>77</td>
<td>49</td>
<td>64%</td>
</tr>
<tr>
<td>Spain</td>
<td>110</td>
<td>60</td>
<td>55%</td>
</tr>
<tr>
<td>Total:</td>
<td>640</td>
<td>403</td>
<td>63%</td>
</tr>
</tbody>
</table>

3.4.3 Classroom observations

In each school, classroom observations were undertaken. These observations were based on a structured observation scheme, containing the following topics:
1) Access to ICT;
2) Use of ICT / other media during the lesson;
3) Lesson activities;
4) Grouping of pupils when using ICT;
5) Opportunity to learn / differentiation;
6) Characterization of ICT use;
7) Coaching and feedback of pupils working with ICT;
8) Characterization of classroom management;
9) Characterization of the learning environment.

All in all, 90 lessons were observed (50 in primary and 40 in secondary classes), resulting in a total of over 72 observation hours (see table 3.2).
Table 3.2 - Classroom observations

<table>
<thead>
<tr>
<th>Country</th>
<th>Primary education</th>
<th>Secondary education</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Hours</td>
</tr>
<tr>
<td>Belgium</td>
<td>8</td>
<td>4.5</td>
</tr>
<tr>
<td>Germany</td>
<td>9</td>
<td>6.8</td>
</tr>
<tr>
<td>Ireland</td>
<td>16</td>
<td>9.7</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>4</td>
<td>4.8</td>
</tr>
<tr>
<td>Spain</td>
<td>13</td>
<td>10.8</td>
</tr>
<tr>
<td>Total:</td>
<td>50</td>
<td>36.6</td>
</tr>
</tbody>
</table>

Apart from the data collection using the structured observation scheme, notes were taken during the observations, resulting in qualitative descriptions of the activities observed in the classrooms that were visited.

3.4.4 Interviews with teachers

In addition to the activities described above that were performed within the framework of the case-studies, issues with regard to the use and impact of ICT in the classroom were addressed in interviews that were conducted with 32 teachers from schools in The Netherlands. This group included 19 teachers from 9 primary schools and 13 teachers from 7 secondary schools. Among these schools were the five case-study schools.

The topics that were addressed in these interviews include the use of ICT in the classroom, the impact of ICT on the role of the teacher, the ‘added value’ of ICT, and barriers to the use of ICT in these teachers’ classes.
4 Results

4.1 Introduction

In this chapter, the results from the interviews with school principals and/or ICT co-ordinators from the case-study schools, and the results from the teachers’ questionnaire will be summarized. The results from the classroom observations will be reported in detail in this chapter, including several descriptions of innovative as well as less innovative uses of ICT in the classrooms visited. For a short characterization of the schools that are addressed in the case-studies, see section 3.3. Finally, a report will be provided from interviews that were conducted with primary- and secondary-school teachers.

4.2 The interviews with school principals / ICT co-ordinators

In this section, the main conclusions of the interviews with school principals and/or ICT co-ordinators on the topics of support and resources, use of ICT in the schools, effects of ICT, and obstacles to using ICT are summarized. An extensive overview of these interviews is provided in appendix 3.

Support and resources

With regard to the acquisition of hardware, many schools have to engage in fund-raising activities of any kind, acquire money from parents, or acquire (second-hand) hardware from sponsors. Drawing from the regular budget often means making cut-backs in other areas. In primary education, a limited number of computers are often situated inside the classroom, these schools usually not being equipped with a computer room (the Irish schools are an exception here). In secondary schools there usually are computer rooms, while not many teachers have a computer inside their own classroom.

In several countries complaints are made about the lack of adequate in-service teacher training with regard to ICT. To overcome this, teacher training in the schools is often set up by the ICT co-ordinator or by colleagues. In pre-service training, in most cases there is insufficient attention for the use of ICT in education.

With regard to ICT co-ordinators, there are notable differences between the countries. In Belgium there are no appointed ICT co-ordinators. In the Irish schools there are, but
they are not being compensated for their task. In the Dutch schools there are ICT co-ordinators and/or system operators who get some compensation in the sense that they have less teaching hours, but this compensation is less than the time that is actually required to fulfill their tasks.

Use of ICT in the school

The use of ICT in most cases depends upon the personal initiative of teachers. In many schools teachers are free to decide whether or not to use computers. It seems that in primary schools the computers often are better integrated in the lessons, whereas in secondary education the use of ICT is often restricted to certain classes and to certain subjects, mainly informatics. The overloaded and exam-oriented curriculum is in many cases pointed out as being the cause of this. Another aspect which is of importance here, seems to be the access to computers. When computers are located in a separate computer room, teachers may feel it is more difficult to integrate the computers in regular teaching practice.

Effects of using ICT in the school

According to the principals and ICT co-ordinators, several benefits may be noted from using ICT in education. ICT provides more opportunities for individualization as well as for co-operative learning; the pupils' motivation is increased; the pupil-pupil and pupil-teacher communication is enhanced; pupils learn how to handle computers; education is better integrated with 'real life'; the teacher acts more as a coach; teaching time is saved; e-mail provides better opportunities for communication, for teachers as well as pupils, and the Internet is a huge source of information.

Obstacles to ICT

Many obstacles to using ICT in education were put forward in the interviews. The main obstacles seem to be lack of money, which means schools cannot purchase or update all the hardware they consider necessary, and lack of teacher training. In pre-service teacher training, not much attention is given to ICT. In-service training often is absent, or is considered to be inadequate.

Lack of time for teachers to familiarize themselves with the possibilities of ICT, lack of adequate courseware (that is attuned to the curriculum), and lack of time for ICT co-ordination and technical support are also barriers that are mentioned frequently. In secondary education, the curriculum in many cases seems to hinder the increase of ICT
use. The cost of software was also mentioned several times as being an obstacle to ICT use.

4.3 The teachers’ survey

Resources for ICT use

The majority of teachers do not have a computer in their classroom, so they have to use the computer room if they want to use ICT during their lessons. If teachers can access ICT in their classroom, they generally have just one computer. About half of the teacher group states the pupils may access the Internet and/or e-mail.

Reasons for not using ICT

The reason for not using ICT which is mentioned most frequently, is the fact that teachers are not familiar with ICT or feel unsure about it. Lack of hardware, and lack of suitable software were mentioned quite often as well as a reason for not using ICT. Some teachers state there is not enough room in the curriculum for ICT, or they say they do not see the necessity of ICT.

The ICT learning environment

The most popular purpose of ICT use with the teachers in the case-study schools is for exercises: half of the primary teacher group who processed the questionnaire, and one out of three secondary school teachers regularly put ICT into action for this purpose. Consequently, drill and practice exercises are the application types used most frequently. Another type of ICT use which is quite frequently applied, is word processing: pupils use computers to write letters and texts. In primary schools, games and adventures, as well as problem-solving applications are rather popular also. Overall, in secondary education ICT proves to be put into action considerably less often than in primary education. A striking difference concerns the use of problem-solving applications, which is almost absent in secondary education.

As far as grouping of pupils working with ICT is concerned, working in pairs is the approach which is applied most frequently. Whole-class teaching during ICT work is applied only by a minority of teachers. In primary schools it is more often the case that pupils are working in small groups with ICT.
A majority of teachers tell their pupils exactly what they have to do before they start working with computers, and regularly check on them during computer work. In primary schools teachers are more often working with pupils who are not using ICT at that moment, as compared to teachers in secondary schools. This difference may be attributed to the fact that the number of computers available in primary schools in general is very limited, so not all pupils may access a computer simultaneously.

Professional development and support

Using ICT themselves and communicating with colleagues are, according to the teachers, the means that best helped them acquire skills with regard to ICT use. In-service teacher training provided a lot of help for one out of five teachers only. The impact of pre-service teacher training and other ICT training is negligible. Teachers generally claim to get quite some support with regard to ICT use from the ICT co-ordinator (if there is such a co-ordinator) and from the school principal. As far as communication about ICT use is concerned, colleagues from the same school are consulted most frequently. The ICT co-ordinator is also an important information source.

Impact of ICT on the pupils

The ICT-using teachers who took part in the survey in general have very favourable ideas about the influence of ICT on the pupils: a majority think that the pupils’ motivation is better when using ICT, that pupils show more interest in the subject, that ICT has a positive impact on the pupils’ information handling skills, and on their amount of concentration and involvement, that ICT leads to better learning achievements, better learning efficiency, and an improvement of problem-solving skills, as compared to education without ICT use.

Impact of ICT on the teacher

The majority think ICT use has a positive impact on the teacher’s professional development (66 percent), on the efficiency of the teacher’s work (52 percent), and on the teacher’s motivation (50 percent).

With regard to the preparation of lessons, interaction with pupils, keeping track of pupils’ achievements, social contact with pupils, and the teacher’s workload, a substantial group thinks there are no main differences with or without ICT. Only few teachers think these aspects are worse with ICT. The aspect which seems to have the less positive impact, is the influence on the teacher’s workload. One out of five ICT-using
teachers think there is a negative impact at this point. On the other hand one out of three teachers feels ICT has a positive impact on the teachers’ workload.

A majority of the teachers feel using ICT resulted in a shift in the teacher’s role, from a lecturer to a coach. A majority also think using ICT enables them to spend more time assisting pupils who need extra attention, they can do their work more efficiently, and they like being a teacher better because they use ICT.

**Barriers**

The largest barriers to (the increase of) the use of ICT in education, according to the teachers, are the limited availability of time for professional development and the quality of pre-service training. Other significant impediments to ICT use are insufficient access to hardware, and the absence of in-service training. On the whole, the Spanish teachers indicated the least serious barriers to ICT use in education. Lack of time for professional development seems to be most pressing in Ireland and the Netherlands. The availability and quality of teacher training is considered to be a serious barrier to ICT use, especially in Ireland and Germany. Many teachers think the provision of (more, better, ‘tailored’) in-service training may help increasing the use of ICT in the schools.

**4.4 Classroom observations**

Classroom observations have been conducted in ninety lessons in which ICT was used. The observation data consist of quantitative as well as qualitative data. In subsections 4.4.1 to 4.4.3, the results of the quantitative approach will be reported. Subsection 4.4.4 contains descriptions which are based on the qualitative part of the observations. In this subsection, examples of innovative uses of ICT are being discussed.

**4.4.1 Media availability and use**

The majority of classroom observations (68 out of 90) were conducted in computer rooms, the rest in classrooms or (in one case) in a corridor next to the classroom. The observations in the Irish and Spanish schools were all conducted in computer rooms. In German schools, the majority of observations were conducted in the school’s computer room, whereas the Belgian and Dutch observers carried out more observations in classrooms than in computer rooms.
In primary schools there were on average ten computers available for pupils during the lessons that were observed, whereas in secondary schools the average was fifteen computers. These numbers, however, depend upon the location where the lesson takes place. In classrooms there were on average five computers available (in a range from one to nine). In computer rooms the average was fifteen (in a range from eight to thirty). Most of the computers were MS-DOS or MS-Windows-based systems.

The average number of pupils in primary classes was 24 (with a range from 11 to 36), the average number in secondary classes was 17 (with a range from 6 to 26). During the lessons that were observed in classrooms, half of the pupils in the class had the opportunity of working with ICT. Because of the limited number of computers, this means in general that pupils only work for a short period of time with the computer. In computer rooms, in most cases all pupils were using ICT during the lessons observed.

Table 4.1 provides an overview of the media that were used during the lessons that were observed.

Table 4.1 - Use of media during the 90 lessons observed (number and percentage of lessons)

<table>
<thead>
<tr>
<th></th>
<th>Primary education</th>
<th>Secondary education</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>%</td>
</tr>
<tr>
<td><strong>ICT</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>computer(s)</td>
<td>50</td>
<td>100%</td>
</tr>
<tr>
<td>CD-ROM</td>
<td>15</td>
<td>30%</td>
</tr>
<tr>
<td>central presentation monitor</td>
<td>0</td>
<td>----</td>
</tr>
<tr>
<td>modem(s)</td>
<td>4</td>
<td>8%</td>
</tr>
<tr>
<td>interactive videodisc</td>
<td>0</td>
<td>----</td>
</tr>
<tr>
<td><strong>Other media</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>black board / white board</td>
<td>17</td>
<td>34%</td>
</tr>
<tr>
<td>overhead projector</td>
<td>4</td>
<td>8%</td>
</tr>
<tr>
<td>video</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>slides</td>
<td>0</td>
<td>----</td>
</tr>
</tbody>
</table>
Apart from computers, the use of which were the criterion for observing these lessons, the medium that is still being used most is the blackboard. In secondary schools hardly any use of CD-ROM was noted. Just in 3 out of 40 lessons that were observed, this medium was used. Modems were not used often either (4 times in 50 primary school observations, and 6 times in 40 observations in secondary schools). A central presentation monitor was used in quite a number of lessons in secondary classrooms. In about a quarter of the lessons that were observed in secondary schools, the teachers used this medium. In the primary schools that were visited, no central presentation monitors were used. With regard to the traditional media, there is a greater variety in secondary schools, as may be concluded from the observations. In primary school classes, hardly any use of the overhead projector or video was observed. In secondary classes, the overhead projector was used in about a quarter of the lessons, whereas in one out of ten lessons the use of video or slides was noted.

Table 4.2 gives an overview of the types of ICT applications that were observed in the case-study schools.

Table 4.2 - Characterization of ICT use during the 90 lessons observed (50 in primary and 40 in secondary education)

<table>
<thead>
<tr>
<th></th>
<th>Primary educ.</th>
<th>Secondary educ.</th>
<th>--- Total ---</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>%</td>
<td>Number</td>
</tr>
<tr>
<td>Word processing</td>
<td>16</td>
<td>32%</td>
<td>19</td>
</tr>
<tr>
<td>Games</td>
<td>22</td>
<td>44%</td>
<td>3</td>
</tr>
<tr>
<td>Drill and practice exercises</td>
<td>17</td>
<td>34%</td>
<td>6</td>
</tr>
<tr>
<td>Problem-solving applications</td>
<td>11</td>
<td>22%</td>
<td>5</td>
</tr>
<tr>
<td>Internet</td>
<td>2</td>
<td>4%</td>
<td>7</td>
</tr>
<tr>
<td>Simulations</td>
<td>3</td>
<td>6%</td>
<td>5</td>
</tr>
<tr>
<td>Drawing/photo-editing/design</td>
<td>4</td>
<td>8%</td>
<td>4</td>
</tr>
<tr>
<td>Adventures</td>
<td>7</td>
<td>14%</td>
<td>1</td>
</tr>
<tr>
<td>Programming</td>
<td>5</td>
<td>10%</td>
<td>3</td>
</tr>
<tr>
<td>Tutorials</td>
<td>4</td>
<td>8%</td>
<td>3</td>
</tr>
<tr>
<td>Databases</td>
<td>2</td>
<td>4%</td>
<td>4</td>
</tr>
<tr>
<td>Spreadsheets</td>
<td>--</td>
<td>----</td>
<td>4</td>
</tr>
<tr>
<td>Other applications</td>
<td>4</td>
<td>8%</td>
<td>3</td>
</tr>
</tbody>
</table>
In primary schools pupils quite often used games (44 percent of the lessons observed), drill and practice exercises (34 percent), word processors (32 percent), and problem-solving applications (22 percent). Games are often presented as an interlude between applications, which accounts for the fact that games were observed frequently. Applications not listed in table 4.2 ('other applications') in primary education that were observed include e-mail and encyclopaedias on CD-ROM or CD-I.

In secondary schools, word processing was observed most frequently: in half of the number of lessons observed pupils were using a word processor. The use of Internet was quite popular as well (observed in 18 percent of the lessons), contrary to observations in primary schools. Drill and practice type applications (15 percent), problem-solving applications (13 percent), simulations (13 percent), spreadsheets and databases (10 percent) were far less popular than word processing. Applications not listed in the table ('other applications') include e-mail and PowerPoint.

In primary schools there seems to be more variation in ICT use than in secondary schools. Whereas in secondary education just one type of ICT application was observed in more than 20 percent of the classrooms we visited (word processing), in primary education four applications were noted in over 20 percent of the classroom observations (drill and practice exercises, games, word processing, and problem-solving applications). A striking difference is the use of Internet, which was observed quite often in secondary schools and just on a few occasions in primary schools.

4.4.2 Lesson activities, grouping of pupils, and learning content

Lesson activities

Table 4.3 gives an overview of lesson activities that were undertaken in the lessons that were observed in primary schools. In table 4.4 data from the lessons that were observed in secondary schools are summarized.
Table 4.3 - Lesson activities that were undertaken in primary schools (50 lessons)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Number</th>
<th>%</th>
<th>Min.</th>
<th>Max.</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher ...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>is explaining procedural matters (monologue)</td>
<td>35</td>
<td>70%</td>
<td>1</td>
<td>17</td>
<td>6.1</td>
</tr>
<tr>
<td>is explaining learning content (monologue)</td>
<td>16</td>
<td>32%</td>
<td>2</td>
<td>23</td>
<td>8.0</td>
</tr>
<tr>
<td>is asking questions to pupils</td>
<td>16</td>
<td>32%</td>
<td>1</td>
<td>20</td>
<td>6.8</td>
</tr>
<tr>
<td>is giving a demonstration</td>
<td>7</td>
<td>14%</td>
<td>1</td>
<td>12</td>
<td>5.6</td>
</tr>
<tr>
<td>is evaluating assignments by asking questions</td>
<td>5</td>
<td>10%</td>
<td>10</td>
<td>45</td>
<td>25.0</td>
</tr>
<tr>
<td>is evaluating assignments in a monologue</td>
<td>5</td>
<td>10%</td>
<td>5</td>
<td>45</td>
<td>20.0</td>
</tr>
<tr>
<td>is testing homework</td>
<td>2</td>
<td>4%</td>
<td>5</td>
<td>5</td>
<td>5.0</td>
</tr>
<tr>
<td>is discussing test results</td>
<td>0</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pupils ...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>work individually without ICT</td>
<td>17</td>
<td>34%</td>
<td>15</td>
<td>56</td>
<td>32.4</td>
</tr>
<tr>
<td>work in small groups without ICT</td>
<td>10</td>
<td>20%</td>
<td>20</td>
<td>56</td>
<td>32.6</td>
</tr>
<tr>
<td>are working on a test</td>
<td>0</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICT work:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>whole class works with ICT</td>
<td>25</td>
<td>50%</td>
<td>20</td>
<td>60</td>
<td>39.3</td>
</tr>
<tr>
<td>part of the class works with ICT</td>
<td>24</td>
<td>48%</td>
<td>2</td>
<td>65</td>
<td>34.9</td>
</tr>
<tr>
<td>other lesson activity</td>
<td>4</td>
<td>8%</td>
<td>5</td>
<td>15</td>
<td>11.0</td>
</tr>
</tbody>
</table>

Explanation: 'Number' refers to the number of lessons in which the activity in question was observed; 'min' refers to the minimum duration of the activity in minutes; 'max' refers to the maximum duration in minutes; 'mean' refers to the average duration of the activity if it occurs. The average duration of the observations in primary classes was 44 minutes (in a range from 20 to 130).

In primary schools, a quite lengthy activity is the evaluation of assignments, which on average takes 20 minutes (in case of a teacher monologue) or 25 minutes (when the teacher is asking questions). These activities, however, were observed in only 10 percent of the lessons. Three activities were observed quite often: the teacher explaining procedural matters, the teacher explaining learning content, and the teacher asking questions (without evaluating particular assignments). On average these activities took little time: 6 to 8 minutes. Among 'other lesson activities' (see table 4.3) are a sharing and a role play.

Pupils are often working individually without ICT (in one third of the lessons this was observed, with an average duration of 32 minutes), or in small groups without ICT (in one of five lessons, average duration 33 minutes). In fifty percent of the observations,
the whole class worked with ICT at the same time (with an average duration of 39 minutes), whereas in the other half of classroom observations, only part of the class was using ICT (with an average duration of 35 minutes).

Table 4.4 - Lesson activities that were undertaken in secondary schools (40 lessons)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Number</th>
<th>%</th>
<th>Min.</th>
<th>Max.</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>The teacher ...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>is explaining procedural matters (monologue)</td>
<td>30</td>
<td>75%</td>
<td>1</td>
<td>20</td>
<td>6.8</td>
</tr>
<tr>
<td>is asking questions to pupils</td>
<td>16</td>
<td>40%</td>
<td>1</td>
<td>45</td>
<td>16.1</td>
</tr>
<tr>
<td>is giving a demonstration</td>
<td>12</td>
<td>30%</td>
<td>1</td>
<td>45</td>
<td>9.9</td>
</tr>
<tr>
<td>is explaining learning content (monologue)</td>
<td>10</td>
<td>25%</td>
<td>2</td>
<td>38</td>
<td>13.6</td>
</tr>
<tr>
<td>is evaluating assignments by asking questions</td>
<td>5</td>
<td>13%</td>
<td>10</td>
<td>15</td>
<td>11.0</td>
</tr>
<tr>
<td>is evaluating assignments in a monologue</td>
<td>4</td>
<td>10%</td>
<td>5</td>
<td>43</td>
<td>18.3</td>
</tr>
<tr>
<td>is testing homework</td>
<td>4</td>
<td>10%</td>
<td>1</td>
<td>10</td>
<td>3.8</td>
</tr>
<tr>
<td>is discussing test results</td>
<td>4</td>
<td>10%</td>
<td>1</td>
<td>10</td>
<td>6.0</td>
</tr>
<tr>
<td>Pupils ...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>work in small groups without ICT</td>
<td>6</td>
<td>15%</td>
<td>5</td>
<td>105</td>
<td>39.2</td>
</tr>
<tr>
<td>are working on a test</td>
<td>4</td>
<td>10%</td>
<td>10</td>
<td>45</td>
<td>22.5</td>
</tr>
<tr>
<td>work individually without ICT</td>
<td>2</td>
<td>5%</td>
<td>5</td>
<td>25</td>
<td>15.0</td>
</tr>
<tr>
<td>ICT work:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>whole class works with ICT</td>
<td>32</td>
<td>80%</td>
<td>10</td>
<td>81</td>
<td>43.6</td>
</tr>
<tr>
<td>part of the class works with ICT</td>
<td>2</td>
<td>5%</td>
<td>15</td>
<td>20</td>
<td>17.5</td>
</tr>
<tr>
<td>other lesson activity</td>
<td>9</td>
<td>23%</td>
<td>2</td>
<td>81</td>
<td>26.4</td>
</tr>
</tbody>
</table>

Explanation: 'Number' refers to the number of lessons in which the activity in question was observed; 'min' refers to the minimum duration of the activity in minutes, 'max' refers to the maximum duration in minutes; 'mean' refers to the average duration of the activity if it occurs. The average duration of the observations in secondary classes was 54 minutes (in a range from 35 to 115).

In secondary schools, explaining learning content in a teacher monologue and asking questions to pupils on average takes twice the time that was noted in primary classes (see table 4.4). To the evaluation of assignments by asking questions, however, teachers on average allocate only about half as much time as their counterparts in primary classes. 'Other activities' include two office simulations, saving work, handing out material, and printing results of the pupils' work.
At some points there are significant differences between lessons in primary and lessons in secondary education. In secondary education pupils hardly worked individually without ICT. This activity was observed in one of twenty lessons only, whereas in primary schools it was observed in one of three lessons. Moreover, when it occurred, the duration was about half the time that was attributed to it in primary classes. As far as the use of ICT is regarded, in secondary education it is more often the case that the whole class works with ICT. This was observed during 80 percent of lessons, as opposed to 50 percent in primary classes. This discrepancy may be attributed to the fact that the majority of lessons in secondary education takes place in the school's computer room.

**Grouping of pupils during ICT use**

During ICT work, pupils that were observed in secondary-school classes work significantly more often individually than pupils in primary education (see table 4.5).

**Table 4.5 - Grouping of pupils during ICT work**

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>%</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary schools</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pupils are working individually</td>
<td>18</td>
<td>36%</td>
<td>20</td>
<td>70</td>
<td>39.8</td>
</tr>
<tr>
<td>pupils are working in pairs</td>
<td>30</td>
<td>60%</td>
<td>20</td>
<td>60</td>
<td>39.3</td>
</tr>
<tr>
<td>pupils are working in small groups</td>
<td>14</td>
<td>28%</td>
<td>15</td>
<td>57</td>
<td>33.6</td>
</tr>
<tr>
<td><strong>Secondary schools</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pupils are working individually</td>
<td>27</td>
<td>68%</td>
<td>3</td>
<td>81</td>
<td>41.1</td>
</tr>
<tr>
<td>pupils are working in pairs</td>
<td>26</td>
<td>65%</td>
<td>3</td>
<td>105</td>
<td>40.4</td>
</tr>
<tr>
<td>pupils are working in small groups</td>
<td>7</td>
<td>18%</td>
<td>21</td>
<td>50</td>
<td>34.4</td>
</tr>
</tbody>
</table>

*Explanation: 'Number' refers to the number of lessons in which the activity in question was observed; 'min' refers to the minimum duration of the activity in minutes; 'max' refers to the maximum duration in minutes; 'mean' refers to the average duration of the activity if it occurs. The average duration of the observations in secondary classes was 54 minutes (in a range from 35 to 115).*

In primary education, pupils often worked in pairs with computers. Working in pairs was observed during 60 percent of the respective lessons. In secondary schools, working in pairs was observed about as often as working individually with ICT (in two out of three lessons), mainly because it often occurs at the same time: in computer rooms part of the class often works individually, whereas the other part works in pairs, which may be attributed to the number of computers available and to pupils' preferences.
Opportunity to learn

Figure 4.1 provides an impression of the extent to which differentiation was realized in the lessons that were observed. In general, it was quite often noted that all pupils were supposed to work with the same learning content. All pupils often had to perform the same learning activities and use the same learning materials. The degree of individualization was considered to be not very high. There were not many remedial activities, nor higher-level activities. The use of discovery learning materials was rather restricted as well.

Table 4.6 - Opportunity to learn / differentiation; primary and secondary classes

<table>
<thead>
<tr>
<th></th>
<th>Primary educ. Mean</th>
<th>SD</th>
<th>Secondary educ. Mean</th>
<th>SD</th>
<th>Signif.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The same learning content for all pupils</td>
<td>3.3</td>
<td>1.6</td>
<td>4.0</td>
<td>1.2</td>
<td>p&lt;.05</td>
</tr>
<tr>
<td>The same learning activities for all pupils</td>
<td>3.9</td>
<td>1.4</td>
<td>4.5</td>
<td>0.8</td>
<td>p&lt;.05</td>
</tr>
<tr>
<td>The same learning materials for all pupils</td>
<td>4.0</td>
<td>1.5</td>
<td>4.3</td>
<td>1.0</td>
<td>Not signif.</td>
</tr>
<tr>
<td>Degree of individualization in the class</td>
<td>3.6</td>
<td>1.3</td>
<td>2.8</td>
<td>1.3</td>
<td>p&lt;.01</td>
</tr>
<tr>
<td>Remedial activities</td>
<td>2.0</td>
<td>1.5</td>
<td>1.9</td>
<td>1.4</td>
<td>Not signif.</td>
</tr>
<tr>
<td>Higher-level activities</td>
<td>2.1</td>
<td>1.2</td>
<td>1.8</td>
<td>1.2</td>
<td>Not signif.</td>
</tr>
<tr>
<td>Use of discovery learning materials</td>
<td>2.9</td>
<td>1.3</td>
<td>2.4</td>
<td>1.4</td>
<td>Not signif.</td>
</tr>
</tbody>
</table>

Explanation: mean scores are scores on a five-point Likert scale, ranging from 1 ('Hardly any') to 5 ('Very often').
Table 4.6 shows that in classroom observations in secondary schools it was observed significantly more frequently that there was the same learning content for all pupils. The same goes for the learning activities. Consequently, the degree of individualization in the class was significantly less in secondary classrooms that were visited than in primary classrooms.

4.4.3 The role of the teacher

Within the framework of the classroom observations, the role of the teacher was addressed with regard to coaching and feedback of pupils working with ICT, classroom management, and the extent to which the learning environment is pupil-centred.

Coaching and feedback

Figure 4.2 gives an impression of the way in which teachers were coaching pupils working with ICT, and of the nature of the feedback the teachers provided the pupils with.

Figure 4.2 - Coaching and feedback of pupils working with ICT

<table>
<thead>
<tr>
<th></th>
<th>No</th>
<th>.</th>
<th>.</th>
<th>Very often</th>
</tr>
</thead>
<tbody>
<tr>
<td>The teacher is walking around the classroom, coaching pupils</td>
<td></td>
<td>.</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>The teacher is spending a lot of time on a few groups/pupils</td>
<td>.</td>
<td>*</td>
<td>.</td>
<td></td>
</tr>
<tr>
<td>The teacher helps pupils by referring to ways to solve problems</td>
<td>.</td>
<td>.</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>The teacher asks questions in order to help solving problems</td>
<td>.</td>
<td>.</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>The teacher gives the answers to questions himself</td>
<td>.</td>
<td>.</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>The teacher takes control of the pupils' computers</td>
<td>.</td>
<td>.</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

In general, the teachers spent quite some time walking around the classroom during the lessons that were observed, coaching pupils. Meanwhile, they were dividing their time over groups or pupils working with ICT roughly equally. Questions pupils posed generally were not answered directly by the teachers, but teachers tended to provide help by referring to ways to solve problems or they asked questions to the pupils in order to
solve their problem. Teachers did not often take control of the pupils’ computers as a
reaction to a question.

There were no significant differences with regard to coaching and feedback between
observations in primary and secondary schools. There are some significant differences
between countries (see table 4.7), as well as some significant differences connected with
the location where the observation took place (i.e. in the classroom or in the computer
room - see table 4.8). Since in two of the countries, Ireland and Spain, all lessons were
observed in computer rooms, it is difficult to draw conclusions with regard to differences
between countries at this point.

Table 4.7 - Coaching and feedback of pupils working with ICT; by country

<table>
<thead>
<tr>
<th>The teacher...</th>
<th>BEL</th>
<th>GER</th>
<th>IRL</th>
<th>NL</th>
<th>ESP</th>
<th>Signif.</th>
</tr>
</thead>
<tbody>
<tr>
<td>is walking around the classroom, coaching pupils</td>
<td>3.7</td>
<td>4.2</td>
<td>3.6</td>
<td>3.0</td>
<td>4.9</td>
<td>p&lt;.001</td>
</tr>
<tr>
<td>is spending a lot of time on a few groups/pupils</td>
<td>2.2</td>
<td>2.3</td>
<td>2.4</td>
<td>2.1</td>
<td>2.1</td>
<td>Not sign.</td>
</tr>
<tr>
<td>helps pupils by referring to ways to solve problems</td>
<td>3.0</td>
<td>3.7</td>
<td>2.8</td>
<td>2.9</td>
<td>4.0</td>
<td>p&lt;.01</td>
</tr>
<tr>
<td>asks questions in order to help solving problems</td>
<td>2.2</td>
<td>3.5</td>
<td>2.8</td>
<td>2.5</td>
<td>3.7</td>
<td>p&lt;.001</td>
</tr>
<tr>
<td>gives the answers to questions himself</td>
<td>2.0</td>
<td>1.5</td>
<td>1.4</td>
<td>2.0</td>
<td>3.5</td>
<td>p&lt;.001</td>
</tr>
<tr>
<td>takes control of the pupils' computers</td>
<td>1.6</td>
<td>1.8</td>
<td>1.9</td>
<td>1.8</td>
<td>2.6</td>
<td>Not sign.</td>
</tr>
</tbody>
</table>

Explanation: mean scores are scores on a five-point Likert scale, ranging from 1 ('Hardly any') to 5 ('Very often').

Table 4.8 - Coaching and feedback of pupils working with ICT; by location of the computers

<table>
<thead>
<tr>
<th>The teacher...</th>
<th>Classroom Mean</th>
<th>SD</th>
<th>Computer room Mean</th>
<th>SD</th>
<th>Signif.</th>
</tr>
</thead>
<tbody>
<tr>
<td>is walking around the classroom, coaching pupils</td>
<td>3.4</td>
<td>1.5</td>
<td>4.2</td>
<td>1.2</td>
<td>p&lt;.05</td>
</tr>
<tr>
<td>is spending a lot of time on a few groups/pupils</td>
<td>2.4</td>
<td>1.2</td>
<td>2.2</td>
<td>1.1</td>
<td>Not signif.</td>
</tr>
<tr>
<td>helps pupils by referring to ways to solve problems</td>
<td>2.8</td>
<td>1.1</td>
<td>3.6</td>
<td>1.2</td>
<td>p&lt;.01</td>
</tr>
<tr>
<td>asks questions in order to help solving problems</td>
<td>2.4</td>
<td>1.0</td>
<td>3.3</td>
<td>1.1</td>
<td>p&lt;.005</td>
</tr>
<tr>
<td>gives the answers to questions himself</td>
<td>1.7</td>
<td>1.1</td>
<td>2.2</td>
<td>1.2</td>
<td>Not signif.</td>
</tr>
<tr>
<td>takes control of the pupils' computers</td>
<td>1.5</td>
<td>0.9</td>
<td>2.1</td>
<td>1.3</td>
<td>Not signif.</td>
</tr>
</tbody>
</table>

Explanation: mean scores are scores on a five-point Likert scale, ranging from 1 ('Hardly any') to 5 ('Very often').
Results

The Spanish teachers were walking around the classroom and coaching pupils frequently, whereas the Dutch teachers did substantially less walking around the classroom. The latter may be explained by the way computers were used in several primary classes in The Netherlands. In these classes pupils were doing exercises autonomously with computers, without needing any help from the teacher. Spanish teachers referred more often to ways to solve problems than teachers from other countries did. German and Spanish teachers more often asked questions as a response to pupils’ questions than teachers from other countries did. Spanish teachers also frequently answered pupils’ questions, instead of giving clues in order to stimulate the pupils to find the answer themselves.

In computer rooms, teachers were observed walking around the room more often, coaching pupils. Teachers in computer rooms also seemed to be helping pupils more frequently by referring to ways to solve problems or by asking questions in order to help pupils solve problems, as compared to teachers in ordinary classrooms. In a two-way analysis of variance, with country and location of computers as independent variables, significant effects of country as well as location only arose with regard to the teacher referring to ways to solve problems.

Classroom management

An impression of classroom management during the lessons observed is given in figure 4.3. During lessons in which ICT was used, there generally was clarity on the desired pupil behaviour, and teachers showed they knew what pupils were doing. In general, teachers did not immediately correct pupils in case of disorder. A certain extent of disorder was considered acceptable by most teachers. All items show significant differences between countries, as table 4.9 shows. With respect to all items, teachers in the Irish cases were rated less positively than the other teachers. The Irish teachers seemed to be less clear about what they expected from their pupils, they did not show very clearly they knew what the pupils were doing, and they were less active in preserving order than their colleagues from other countries. The location of computers (classroom or computer room) showed no significant influence after correction for country differences. However, as stated before, in two countries all observations took place in computer rooms.
Figure 4.3 - Classroom management in ICT learning environments

<table>
<thead>
<tr>
<th></th>
<th>No</th>
<th>3</th>
<th>5</th>
<th>Very often</th>
</tr>
</thead>
<tbody>
<tr>
<td>There is clarity on desired pupil behaviour</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>Teacher preserves order</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher shows in own behaviour he/she knows what pupils do</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>Teacher corrects the right pupils in case of disorder</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>Teacher corrects immediately in case of disorder</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

Table 4.9 - Classroom management in ICT learning environments; by country

<table>
<thead>
<tr>
<th></th>
<th>BEL</th>
<th>GER</th>
<th>IRL</th>
<th>NL</th>
<th>ESP</th>
<th>Signif.</th>
</tr>
</thead>
<tbody>
<tr>
<td>There is clarity on desired pupil behaviour</td>
<td>4.7</td>
<td>4.4</td>
<td>2.3</td>
<td>4.0</td>
<td>4.2</td>
<td>p&lt;.001</td>
</tr>
<tr>
<td>Teacher shows he/she knows what pupils do</td>
<td>4.1</td>
<td>4.1</td>
<td>2.3</td>
<td>3.9</td>
<td>4.6</td>
<td>p&lt;.001</td>
</tr>
<tr>
<td>Teacher preserves order</td>
<td>3.8</td>
<td>3.4</td>
<td>2.4</td>
<td>3.5</td>
<td>3.1</td>
<td>p&lt;.001</td>
</tr>
<tr>
<td>Teacher corrects immediately in case of disorder</td>
<td>4.0</td>
<td>3.0</td>
<td>2.1</td>
<td>3.0</td>
<td>4.0</td>
<td>p&lt;.001</td>
</tr>
<tr>
<td>Teacher corrects the right pupils in case of disorder</td>
<td>3.6</td>
<td>4.4</td>
<td>2.4</td>
<td>4.0</td>
<td>2.7</td>
<td>p&lt;.001</td>
</tr>
</tbody>
</table>

Explanation: mean scores are scores on a five-point Likert scale, ranging from 1 ('No') to 5 ('Very often').

Significant differences between observations in primary and secondary classes (after correction for differences between countries) only came forward with regard to the teacher showing in his/her own behaviour that he/she knows what the pupils are doing. In secondary classes (mean score=4.1) this was more often the case than in primary classrooms (mean score=3.7).

Characterization of the learning environment

Many of the learning environments that were observed were rated more pupil-centred than teacher-centred. There often was more emphasis on pupils constructing knowledge than on teachers transferring knowledge, and teachers in general were acting more as coaches than as lecturers. However, this does not mean pupils were more in control than
Teachers in general were observed to be just as much in control of the learning environment as pupils were (see figure 4.4).

**Figure 4.4 - Characterization of the ICT learning environment**

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher-centred</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher transfers knowledge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher as a lecturer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Teacher in control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>Pupil-centred</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pupils construct knowledge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher as a coach</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pupils in control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

With regard to two aspects, significant differences between countries as well as between primary and secondary classes were found. The learning environments observed in Belgian and Irish classes were rated less pupil-centred than those in Germany, Spain, and The Netherlands. In The Netherlands there was more emphasis on pupils constructing knowledge than in the other countries (see table 4.10).

**Table 4.10 - Characterization of the ICT learning environment: by country**

<table>
<thead>
<tr>
<th></th>
<th>BEL</th>
<th>GER</th>
<th>IRL</th>
<th>NL</th>
<th>ESP</th>
<th>Signif.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pupil-centred</td>
<td>4.4</td>
<td>5.7</td>
<td>4.4</td>
<td>6.3</td>
<td>5.9</td>
<td>p&lt;.001</td>
</tr>
<tr>
<td>Pupils constructing knowledge</td>
<td>5.0</td>
<td>4.9</td>
<td>4.2</td>
<td>6.0</td>
<td>5.2</td>
<td>p&lt;.005</td>
</tr>
<tr>
<td>Teacher acts as a coach</td>
<td>4.8</td>
<td>5.3</td>
<td>4.6</td>
<td>6.4</td>
<td>5.2</td>
<td>Not signif.</td>
</tr>
<tr>
<td>Pupils are in control</td>
<td>3.6</td>
<td>4.0</td>
<td>4.4</td>
<td>5.1</td>
<td>4.2</td>
<td>Not signif.</td>
</tr>
</tbody>
</table>

*Explanation: mean scores are scores on a seven-point Likert scale, ranging from 1 ('Not at all') to 7 ('Very much').*

In primary schools, lessons that were observed in general were more pupil-centred than in secondary schools, and there was more emphasis on pupils constructing knowledge (see table 4.11). As for the questions with regard to the extent to which the teacher acts
as a coach, and the extent to which pupils are in control, no significant differences between primary and secondary classes were observed.

**Table 4.11 - Characterization of the ICT learning environment; primary and secondary classes**

<table>
<thead>
<tr>
<th></th>
<th>Primary educ.</th>
<th>Secondary educ.</th>
<th>Signif.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Pupil-centred</td>
<td>5.5</td>
<td>1.5</td>
<td>4.8</td>
</tr>
<tr>
<td>Pupils constructing knowledge</td>
<td>5.2</td>
<td>1.5</td>
<td>4.6</td>
</tr>
<tr>
<td>Teacher acts as a coach</td>
<td>5.1</td>
<td>1.3</td>
<td>5.0</td>
</tr>
<tr>
<td>Pupils are in control</td>
<td>4.3</td>
<td>1.5</td>
<td>3.9</td>
</tr>
</tbody>
</table>

*Explanation: mean scores are scores on a seven-point Likert scale, ranging from 1 ('Not at all') to 7 ('Very much').*

**4.4.4 Innovative uses of ICT in the classroom**

As may be concluded from the preceding subsections, many approaches with regard to the use of ICT in the classroom that were observed in the case-studies were not of an innovative nature. Several observations concern applications which may be characterized as behaviourist drill and practice exercises. These applications are appreciated by many teachers since they automate exercises. This leads to time saving for the teacher, because s/he does not have to check the pupils' progress and give feedback to them while they are doing their exercises. Many programs store results of the pupils' actions in a database, which may be consulted by the teacher after the lesson has finished. This approach, however, leaves no room for pupil initiative.

Other types of approaches which may not be considered innovative, are approaches in which no higher-order thinking skills are stimulated, e.g. because the pupils are expected to follow the teacher's instructions exactly, or because the pupils have to copy a text from a book. Approaches in which pupils are more or less left on their own, without being given any clues about what is expected from them, are examples of not innovative uses of ICT as well.

In this subsection, some innovative uses of ICT that have been observed will be highlighted. These innovative approaches are presented as ten descriptions of lessons that
were observed. Table 4.12 provides an overview of the characteristics of the respective lessons. Concluding remarks with regard to the extent to which these approaches confirm the hypotheses that were presented in subsection 2.4.8, will be presented in section 5.4.

Table 4.12 - Overview of characteristics of the innovative approaches listed

<table>
<thead>
<tr>
<th>Learning environment:</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
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<tbody>
<tr>
<td>- authentic context</td>
<td>*</td>
<td>*</td>
<td>*</td>
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<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
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<td>*</td>
</tr>
<tr>
<td>- multiple perspectives</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- differentiation of content</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
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<td>*</td>
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<table>
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<tbody>
<tr>
<td>- social skills</td>
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</table>

<table>
<thead>
<tr>
<th>Teacher role:</th>
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<th>3</th>
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<th>6</th>
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<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>- facilitator</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>- gives clues</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Grouping of pupils:</th>
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<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>- individual work</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- pairs / small groups</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
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<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
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</tbody>
</table>

Explanation: The numbers refer to the subsequent case descriptions in the text frames.
Table 4.12 (continued)

<table>
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<tr>
<th>Application type:</th>
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<th>4</th>
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<th>8</th>
<th>9</th>
<th>10</th>
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<tbody>
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<tr>
<td>- simulation</td>
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<tr>
<td>- Internet</td>
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<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- e-mail</td>
<td>*</td>
<td></td>
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<td></td>
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<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- word processing</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>- drawing</td>
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<td></td>
<td></td>
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<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>- other applications</td>
<td>*</td>
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<td></td>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>

Explanation: The numbers refer to the subsequent case descriptions in the text frames.

Descriptions of innovative lessons including ICT-related activities

Each description (in a text frame) is followed by a brief characterization of the approach in question.

1) Primary school; Ireland; ages 11-12; development of English writing skills

In this case, instruction takes place in the computer room. It is equipped with 11 Acorn computers which are networked. The pupils are in 6th Class, which is the final year of primary school. The main objective of the session is the development of English writing skills.

The pupils have the task of typing up letters they have already composed and hand-written before in the classroom. The letters are about themselves and will be sent to individual pupils in a school in the United States by e-mail. The pupils in the school in the USA will respond to their letters. Initially the letters are about the pupils themselves, but it is anticipated that in on-going e-mail dialogue with their American counterparts the themes of future letters will be broader, describing the pupils' neighbourhoods and community. This may involve doing some research. In this session the pupils work in pairs. The teacher does not need to walk around the room very often. There is a good deal of communication between the groups. The teacher thinks this is a good thing.
The teacher tells pupils to get up a new page by double-clicking on the Edit menu to get a new file. Then the teacher tells them they can start writing. The teacher commands: 'hands off, listen'. He instructs them to start their letters at the top left of the page, begin with Dear X, followed by a comma - then press the 'Enter' key. The children begin to type their letter. The teacher says to call him if they have any problems or questions. The teacher tells pupils that after they have saved their letters they can be sent by e-mail. He also uses the blackboard for a moment to write down 'format 72' - which is the width of page/column he suggests they use for their letters. He walks around checking grammar, spelling and punctuation. He tells pupils that when they have finished their letters they can use the Desk Top Publishing software if they wish.

Towards the end of the session the teacher tells pupils they’d 'want to speed up now, you’re running out of time'. At this stage there are more pupils asking for advice or support. It is mainly the teacher responding rather than intervening.

This case is interesting because it is a good example of how the use of ICT can be linked in with other school work. It also shows how the Internet can be used to good effect. Pupils have been preparing their work in an earlier lesson. The teacher acts as a coach who gives some instructions he thinks are necessary, but stays in the background most of the time while pupils are working collaboratively. He is walking around, monitoring what the pupils are doing. Problems arising during computer work are to a large extent solved by pupils in communication with other pupils.

2) Primary school; Ireland; ages 11-12; problem-solving activity

In this case, instruction takes place in the computer room in this primary school. It is equipped with 11 Acorn computers which are networked. Some of the computers are nearly 10 years old. The computers are arranged around the walls of the room.

In this session the pupils, who are in 6th Class, are using the 'Crystal Forest' software. This is a combination of adventure/puzzle-solving activity. The pupils have the task of finding objects, clues and undertaking tasks. But, to achieve actions it is often necessary to write some lines of programming code. For example, in one situation the pupils have to get robots to move through a type of maze. To make them move they have to provide them with instructions - 'walk 14, jump, jump, turn left, walk 5'. Another task involves making a type of suspension bridge. In this case the pupils have to work out the angles at which the ropes holding up the bridge go up and down.
The teacher checks to see that each group has loaded the software. He gives some of those who are stuck clues and suggests 'now see what happens'. However, the pupils work very much by themselves. On one or two occasions the teacher asks that the level of noise be reduced. After 15 minutes the groups are working on different elements of the program. After another 15 minutes the teacher announces end of class and asks three pupils to remain behind to ensure all the computers and monitors are turned off and chairs put back.

This is an interesting case because it illustrates a situation where the pupils are self-motivated to work and where the teacher's role is mainly one of responding to requests for assistance. He is acting as a coach who does not answer pupils' questions directly, but who tries to stimulate them to solve problems themselves by providing clues. Meanwhile the teacher is monitoring the progress of the pupils, who are used to working autonomously.

3) Primary school (grade 8); The Netherlands; ages 11–12; information handling skills

During one hour every week there is special emphasis on information handling skills of the pupils in grade 8. There are 26 pupils in the classroom. Two computers, one of them equipped with a CD-ROM player, and a CD-I player, attached to a monitor, are available. Because there is not enough room inside the classroom, the equipment is in the corridor.

After a short introduction by the teacher, he selects three pupils from the class. These pupils may choose pupils they would like to work with. Three pairs are formed, who then leave the classroom and go to the corridor to use the ICT equipment. The teacher is accompanying them. The pairs that were formed work together for the whole hour, with the teacher assisting them. There is a student teacher who stays with the rest of the class. Pupils in the classroom are using information booklets on various topics to acquire information. In cases when there is no student teacher available, the teacher has to assist pupils inside as well as outside the classroom, walking around from classroom to corridor and vice versa.

Two girls are going to learn how to use the word processor (MS Word). The teacher assists them in starting up the program. After that, they start reading instructions in a training booklet ('MS Word for Children') and they are carrying out assignments at the keyboard. Several times they ask the teacher for assistance. He then tells them what they are supposed to do, or he points at the appropriate written instructions.
Results

(Continued)

Two boys are sitting at the multimedia computer. They are assigned to look for information on a CD-ROM that fits the subject they have been reading about last week. These pupils have no difficulty starting up the equipment. They are using a CD-ROM encyclopaedia in which the functioning of various pieces of equipment is being explained (e.g., engines, computers, the telephone, video cassette recorders). Since the information the CD-ROM provides does not cover the subject they have been reading about, the teacher tells them to look up information they think is interesting. They are working very dedicatedly, in a co-operative way, searching for and viewing information about several machines. They hardly need any assistance from the teacher.

Meanwhile two girls are searching a CD-I (which contains an animal encyclopaedia) for information about owls, which was the topic they worked on a week earlier. The teacher assisted them to get the equipment running. Quite soon however, they are deviating from their subject, after having viewed only part of the information which is available. The teacher turns to them several times, providing them with search keywords, assisting them in browsing the information, and (after 20 minutes) inserting a second CD-I at the moment they can’t find any new information. Since there seems to be no information with regard to their subject on this CD-I, they start browsing information regarding other topics. When classes end, the teacher helps the girls to shut down the equipment. The boys do not need any help in this respect.

This observation shows an attempt to utilize ICT in order to stimulate pupils’ information handling skills. It also shows several problems teachers may be confronted with when doing this. Firstly, the number of computers is limited, and the equipment is situated in the corridor, because of the limited space inside the classroom. This means the teacher has to be in two places at the same time. In this case, the availability of a student teacher solves the problem, but if the student teacher is absent, the teacher has to divide his attention between pupil groups inside as well as outside the classroom. Secondly, the material which is available on CD-ROM and CD-I does not match the information from the booklets very well. This makes it difficult to present the information from these media as a complement to the information the pupils gathered in the preceding lessons. Thirdly, the limited availability of multimedia equipment, as well as the limited number of software titles available, restricts the opportunity to present pupils with an abundance of information.
4) Secondary school (grade 4 of pre-vocational education); the Netherlands; ages 16-17; office simulation

In this school, students of pre-vocational education are prepared for office jobs by means of an office simulation. Just like in real offices, ICT plays an important role in this respect. The school has a special practice room at its disposal which is fitted out as an office. There are several ‘departments’: reception, sales department, acquisition department, warehouse department, financial department, personnel department. The usual office equipment is available, including desks, 7 computers, 4 printers, 2 typewriters, a phone, a telefax, and a copier. The firm, called Bodyhouse, specializes in ‘selling’ products like body lotion, soap, etc.

There are 15 pupils in this group. In each department, there are two or three pupils. There is a rotation system, so the students are working at various departments during the school year. They stay in a department for two or three weeks, and then they move on to another. Because they do not leave their department all at the same moment, there is always one student who can help the newcomers at the respective department.

The school is associated with an agency (‘Simnet’) that is providing the firm with orders and requests for information (by mail, fax or phone), in order to make the simulation more realistic. There are plans to start co-operating with simulated offices in other schools in the near future. The number of computers will be extended to fifteen: a local bank is fitting out the school with equipment and furniture. The software that is being used was not designed for education. It is software which is used in the business world, including a word processor (WordPerfect), a database (PerfectView), a spreadsheet (Lotus), and a package for producing invoices (CombiStart). Stand-alone computers are used, which hampers the exchange as well as the backing up of computer files. There are plans to set up a computer network, and there are plans to switch over to MS Office.

Pupils are expected to work co-operatively within their department, as well as with other departments. The classroom observations show they are indeed quite actively involved in the simulation. The teacher acts as ‘office manager’. He is walking around the office, answering questions, monitoring progress, giving assignments, and assisting students. Since the office simulation project started only recently, two teachers are present in the office. Pupils are in this office for two hours per week. The next school year, one teacher will run the office, which will then be in operation for four hours per week per group of pupils.

At the start of the class, one teacher starts explaining a new database application he designed to two girls in the warehouse department. He remains working with these girls for a substantial part of the lesson, coaching them to handle the software. After leaving this department, he starts going round the classroom, just like the other teacher, monitoring the pupils’ activities, and assisting pupils when necessary. Before the lesson ends, pupils are instructed to backup their work to a floppy disk. After that, they are invited to close their department.
This description refers to a very sensible way of integrating ICT in education. In this way, pupils are prepared for office jobs in a life-like situation. The simulation is intended as a replacement for on-the-job training, since it is getting more and more difficult for the school to find companies willing to provide that training. Pupils enjoy working together in this manner, as may be concluded from the classroom observation. One of the problems, as noted by one of the teachers, is that sometimes a department runs out of work, and pupils have to wait for another department to finish work. For the teachers, setting up this simulation was very time-consuming. The simulation is still in the start-up stage, which means that the finetuning takes quite some time; new applications are being developed, contacts with other ‘school companies’ have to be established, a PC network has to be installed, and a new software package has to be introduced.

5) Primary school (grade 6/7/8); the Netherlands; ages 9-12; group discussion / e-mail project

There are 19 pupils in this class, which is a mix of three grades, with ages ranging from 9 to 12. Each morning, classes start with a short group discussion, during which pupils discuss things that happened to them, news items, etc. This conversation is co-ordinated by a pupil. The teacher is sitting down with the group. He listens to the discussion and on one or two occasions he poses a question in order to clarify matters.

This morning, one of the items is an e-mail message that was received yesterday from the school in Belgium these pupils correspond with on a regular basis. Pupils discuss the contents of the message, and decide what items should be in the response. The teacher points at a few matters that might not be clear to the pupils in Belgium, which leads to more details in the message the pupils are going to send. After the class has agreed on the contents of the answer, two pupils leave the classroom in order to go to the computer in the teachers’ room, which provides access to e-mail. They are going to type out and mail the class’s reply. Meanwhile, pupils in the classroom select materials from the cupboard, including books and exercises, and start working individually, in pairs, or in small groups. Everyone knows what to do, without the teacher having to interfere. At some occasion, the teacher leaves the classroom for ten minutes, in order to attend to the pupils answering the e-mail. The pupils in the classroom continue working as if the teacher never left the room.

This example shows the use of ICT for enhancing the pupils’ creativity and for creating understanding for cultural differences. The pupils are used to a pupil-centred learning environment. The group discussion shows the pupils are in charge of this activity. The teacher is merely interfering at moments when certain matters have to be clarified. At these occasions, he interferes by posing a question, not by making a remark. The fact that the computer which provides access to e-mail is located outside of the classroom, does
not create any difficulty, since all pupils know what they are expected to do, and they are used to carrying out their tasks even without the presence of the teacher.

6) Secondary school (grade 11); Germany; ages 15-17; social sciences

The group consists of 21 students (13 females, 8 males), aged 15 to 17. We are observing a social science class.

At the beginning of the period, students are given two different texts (complaint to the police concerning the theft from a store, notice of a traffic accident). Students are divided into three groups and each group is assigned one of the following three tasks:
- File a charge to the local court.
- Construct a flow chart that explains the legal procedure (including possible appeal of revision and reasons for involving the particular court(s)).
- Look for help (court decisions that may serve as precedents) as input for a court decision.

The first two tasks are to be done using the word processing program of a computer while for the last task, students will have to access the Internet.

Students work in small groups while the teacher goes from one group to the other. Students ask questions referring to the topic, to matters of orthography and to the use of the computer. The teacher tries not to answer these directly. If the problem already came up in one of the other two groups, he refers to that group and asks them to explain. At the end of the period, students hand in their results in the form of a written text to the teacher. He promises to look at them in depth at home and to return them in the next period, but he already sees that the group working with the Internet has had difficulties finding adequate sources and he tells this group that he will look for Internet sources that will be more helpful.

In this observation, we consider the use of ICT as meaningful because the computer program as well as the Internet are used as tools to accomplish a given task which has a high degree of authenticity.
7) Primary school (6th grade); Belgium; ages 11-12; information gathering

There are 25 pupils in this class. There are no computers in the classroom. Pupils may use one computer (the only one at school) with access to the Internet at the corridor. The classroom is traditional, with pupils sitting in pairs in three rows.

Each morning, before the classes start, 3 pupils of the class have to search on the Internet for some interesting news items. They are allowed to use two Dutch web sites of youth journals. There is always one teacher who assists, and there is also a kind of rotation system so that pupils learn to help each other to use the Internet. In each group there is one pupil for whom it is the first time he/she uses the Internet, one for whom it is the second and one for whom it is the third time. They read the items and each of them selects one item they are really interested in. These items will be printed. When the classes start, they have to tell about the selected news item and a little discussion with the whole class follows.

In this case there are two teachers, one assisting the pupils in browsing the Internet and the other is the regular class teacher who discusses the results of the search in the classroom. The teachers decide on the sites the pupils are allowed to browse. The teacher, who assists the learners in browsing, stimulates pupils to find out themselves how the Internet works. If they need practical support (e.g. how to go to another hyperlink), he assists them, but in such way that the pupils develop the skills to do a search on the Internet themselves. He does not take over the activities, but just gives explanations. The aim is that pupils work collaboratively and learn from each other. The second teacher guides the discussion about the themes selected by the three pupils. She acts as chairperson, who summarizes the different points of view, selects pupils who may address the class, and formulates a conclusion.

In this case ICT is used for gathering information. The teachers argue that the biggest advantage of using Internet for this purpose, instead of using a newspaper, is the fact that the news items have already been selected by these specialized web sites. In this way pupils become aware of ‘the news of the day’ and in the meantime they learn how to work with the Internet. The teacher is there to support this. The learning environment is to a large extent pupil-centred. Even though the teacher limits the pupils’ freedom with regard to the Web sites they are allowed to access, the pupils are free in the subjects they may choose. Thus, the content may be adapted to the pupil’s desires and needs. The pupils are stimulated to be active learners, who gather information, summarize the information they selected, and discuss it with their classmates.
8) Secondary school (grade 6); Belgium; ages 17-18; English

In this class, there are 13 pupils. They have 7 multi-media computers at their disposal, which are located in the back of the classroom.

In this English course the pupils have to select a subject related to the theme ('Indians') they worked on in previous lessons. The pupils work in pairs and the task is to find as much information as possible about the chosen subject. They are obliged to use different media, the more traditional media, like encyclopaedias and books, as well as Internet and CD-ROMs. Afterwards they have to compare the information they found in the different media and discuss their findings. The comparison and discussion was part of the next lesson.

The teacher recalls, together with the pupils what they learned about the theme during previous lessons. He explains the assignment and helps students when they ask for it. He encourages students to find as much information as possible, but also to select the most important or interesting information. He walks around and assists when necessary. Sometimes he gives suggestions to students about where they can find interesting information.

This lesson was the starting point of a small project. The goal of this lesson was purely information gathering and selection. What happens with this information as well as the discussion about the differences between these media were not observed as this was planned for the following lessons. The teacher encourages the students to explore information available from several media, assisting them only when necessary. Students are stimulated to compare information from different information sources. This approach may stimulate their information handling skills.
This lesson is situated in the computer classroom, which has 16 computers with access to Internet. The computer room was booked by the teacher when planning the use of ICT for this English course. The pupils have to form small groups. Each group works on a specific sub-theme (youth movement, dancing, and sports) within the main theme of leisure. The assignment is to write a text in English about the chosen theme to exchange with pupils in Denmark and Latvia. The procedure is that pupils write the text within their small group, which is then corrected by the teacher. After this, the pupils send the text by e-mail to their fellow pupils. The same was asked of the students in the other countries. The aim was that the pupils communicate about and discuss the texts with the other students by e-mail, not only during the lessons, and that they make a presentation based on these texts. The teacher corrects the texts and explains grammar and spelling issues. This lesson was part of a European project that the teacher organized together with teachers from abroad who teach English in Denmark and Latvia. Together they defined the assignments, did all the planning, and made all the arrangements that were necessary.

This type of ICT use provides an opportunity to exchange experiences with foreign students and to learn to co-operate and communicate with students across the borders. In this way, the understanding of other cultures is enhanced, and students are motivated to engage in activities. The learners are very enthusiastic and motivated to work on this project. The teacher, however, had a lot of work organizing this project and making it possible. For the teacher, it provides an opportunity to join forces with fellow teachers from abroad.
This example shows how teachers coach pupils by posing questions and formulating problems. Thus the pupils are stimulated to engage in creative activity. When the teachers consider it appropriate, they provide clear instructions instead of leaving all initiative to the pupils, in order to work efficiently.

4.5 Impressions from interviews with teachers

Within the framework of the Dutch part of the study, several ICT-using teachers have been interviewed with regard to the impact of ICT on their role. These are not only teachers from case-study schools, but also teachers from other schools. Overall, 20 primary school teachers and 13 secondary school teachers were interviewed.

Primary school teachers

An issue which was raised by many teachers (13 out of 20) is that the lack of space is an impediment for the integration of ICT in the classroom. In many classrooms it is difficult to find room for more than two computers. In several schools computers were placed in corridors, which does not create an optimal environment for fostering the learning process. It also affects the role of the teacher, since it is more difficult to monitor what
pupils are doing when part of the class is working outside of the classroom. The number of computers available is also a matter several teachers (8 out of 20) are not satisfied with. Another serious impediment which is raised often, is the lack of time for professional development with regard to ICT. Ten out of twenty teachers mention this issue. The ‘return on investment’ of training is by many teachers considered to be insufficient. Moreover, training often focuses too much on technical aspects of ICT use (like the use of operating systems, word processors, spreadsheets etc.), whereas didactical aspects are neglected.

The greatest advantage of ICT, according to several teachers, is that pupils like using computers. This was mentioned by six teachers. Some teachers add that when pupils are motivated, the teacher has to put less effort into keeping them at work. Other ‘added value’ of ICT, according to teachers interviewed, is the fact that the computer tracks pupils’ achievements (mentioned by four teachers), that the computer provides immediate feedback (three teachers), and that using the computer is more effective (three teachers). It is striking that just two teachers call the computer’s potential with regard to enabling differentiation an added value of the computer.

Among the ICT applications that are being used, arithmetic, language, reading, and geography exercises are mentioned often. Some teachers let their pupils use MS Word, some give their pupils access to the Internet. Apart from this, several CD-ROMs are used, including MS Encarta. As some of the teachers say, the limited access to computers causes the computer to be used mainly for doing exercises. Consequently, this does not influence the role of the teacher very much, according to these teachers. Others state they are more in the background when pupils are working at the computer and there is considerably less whole-class teaching. Two teachers feel that because of ICT use in their classroom they have more time to spend with pupils who need extra attention. Teachers often instruct their pupils to work on their own at the computer, especially when exercises have to be done. This happens in spite of the limited number of computers available.

Secondary school teachers

Secondary school teachers frequently experience lack of time for professional development to be an impediment to ICT use in their classes (mentioned by 7 out of 13 teachers). Consequentially, teachers have insufficient knowledge of the didactical potential of ICT (mentioned by six teachers). Teacher training is often considered to be vague or of bad quality (six teachers), and the computer room in the school is in use too often (five teachers). All secondary schools have a computer room. Teachers are required to book
the computer room, which means they may have to compete with colleagues who want to use it at the same time. Several teachers point at the fact that teachers of informatics have priority when booking the computer room. Consequently, some classes do not get the opportunity to use the computer room at all. Apart from this, teachers have to carefully plan the duration of ICT-related activities once the computer room has been booked.

With regard to the question about the added value of ICT in secondary education, several answers were noted: ICT enables pupils to work independently, pupils like using ICT, it is more effective than education without ICT (all mentioned three times), ICT attracts the pupils’ attention, ICT is crucial to society, so it has to be focussed at in school, and ICT enables pupils to write texts faster (all mentioned two times).

ICT is used within several subjects, but apart from informatics ICT plays a minor role in secondary school subjects. Applications include word processing, exercises (vocabulary, grammar, texts, statistics, etc.), and simulations. Teachers in general prefer educational software which fits the textbooks they use. Some teachers point at the curriculum, which they consider to leave little room for incorporating ICT in their classes.

Some teachers notice a shift in their role, from a lecturer to a guide or a facilitator. A few teachers point out the fact that questions pupils ask are more of a technical nature when ICT is being used. A few teachers emphasize that pupils are often better at the computer than the teachers themselves. However, these teachers do not consider this to be a disadvantage: pupils who know a lot of computers can help their classmates when necessary. Just one teacher explicitly mentions the possibility of adapting the lesson content to the pupils’ needs as an advantage of ICT use. Some teachers state that classroom management is more difficult when ICT is used. A majority of teachers prefer pupils working alone at the computer. Teachers mention the fact that collaborative work results in an increased noise level in the classroom. Apart from this, some pupils put less effort into their work when they are working together with other pupils. This calls for extra attention on the part of the teacher.
5 Conclusions

5.1 Introduction

In the following sections, the main conclusions of this study will be reported. Section 5.2 provides a description of the factors influencing the use of ICT by teachers. In section 5.3 an impression is given of the actual use of ICT by teachers in the classroom, as noted from the empirical part of the study. Section 5.4 addresses the changing role of the teacher in a changing learning environment with ICT. Section 5.5 provides a discussion, including guidelines for optimizing education with ICT. Section 5.6 concludes this chapter with recommendations for stimulating and enhancing ICT use in educational practice.

5.2 Factors influencing the use of ICT by teachers

It goes without saying that in order to enable teachers to implement ICT in their daily teaching practice, several preconditions have to be met. Among these are access to hardware, the availability of appropriate educational software, the availability of adequate teacher training and support, and room for ICT-related activities in the curriculum. The government’s policy as well as the school policy with regard to ICT play an important role in this respect.

In primary and secondary education it is common that every teacher may decide for himself (or herself) whether he (or she) will use ICT in classroom practice. What is crucial at the teacher level in this respect, according to the literature study, are the beliefs and skills of the teachers. These factors are not only critical with regard to the question as to whether or not to use ICT in educational practice, but also with regard to the question of how ICT will be used. Teachers have to see the advantages of ICT use in order to be motivated to implement it in their teaching practice. Apart from this, if teachers are not confident about their capabilities in handling ICT, this may hamper their willingness to introduce ICT in their classroom. Other skills that are important in this respect, are skills related to the teachers’ competence in classroom management activities, and to their pedagogical skills. The reason for not using ICT which is mentioned most frequently by teachers from our case-study schools who completed the questionnaire, is the fact that they are not familiar with ICT or the fact that they feel unsure about ICT. Lack of hardware (in the classroom), lack of suitable software, and lack of opportunity in the curriculum also were mentioned quite often as reasons for not
using ICT in the classroom, but these barriers are clearly not as important as lack of familiarity with ICT. According to the teachers who do use ICT, one of two largest barriers to (the increase of) the use of ICT in education, is the limited availability of time for professional development. This applies especially to teachers from the schools in Ireland and in The Netherlands. Insufficient quality of pre-service training is the second main barrier mentioned by teachers.

According to the school principals and ICT co-ordinators from the twenty-five case-study schools, there are two main obstacles to the implementation of ICT in the schools: lack of money and lack of adequate teacher training. Because of lack of money, schools cannot purchase or update all the hardware they consider necessary. As a consequence of this, the life cycle of ICT in schools is substantially longer than elsewhere. In the business world, ICT equipment as well as software is outdated in a year or even less. In schools, computers and software in general have to be in use for four years or more. It is not uncommon that schools are still using computers that are not capable of running other than DOS-based software. This puts the notion of ‘new technology’ in question, and it restricts the opportunities for teachers to apply current software in their teaching practice. Apart from this, if the availability of equipment is limited, this restricts the access to ICT by teachers who would like to incorporate ICT in their classes. In pre-service teacher training, not much attention is given to ICT. In-service training is often absent, or in several cases is considered to be inadequate. According to the principals as well as teachers, training too often focusses on technical aspects of using ICT, instead of highlighting the didactic consequences and opportunities.

In conversations with teachers, lack of opportunity and/or flexibility is often put forward as a serious problem with regard to incorporating ICT into daily practice. What makes things worse, is that classrooms in new school buildings even tend to be smaller than classrooms in older buildings. Changing learning environments call for functionally flexible school buildings, in which there is sufficient room for equipment and where there are facilities for autonomous learning outside the classrooms as well.

5.3 Actual use of ICT by teachers

In spite of the selection of technology rich schools for the case-studies, the majority of teachers in the case-study schools do not have a computer in their classroom. This means they have to use the computer room if they want to use ICT during their lessons. The majority of teachers who have access to ICT in their classroom, have only one computer available. Computer rooms are more common in secondary schools, whereas in primary
schools these are often absent, a limited number of computers being available in the classrooms instead. In the Irish and Spanish cases, all schools were equipped with a computer room. When there is a computer room, it is usual that the whole class works with ICT during all of the lesson time. In case there is a small number of computers available in the classroom, it is often the case that a limited number of pupils are working with ICT for a limited period of time before swapping places with classmates.

ICT applications that are used most frequently by teachers in the case-study schools, are word processing, and drill and practice exercises. Pupils often use computers to write letters, e-mail messages, and texts. They also often use computers for arithmetic and language exercises. There are some notable differences between primary and secondary schools with respect to the use of ICT. Firstly, in secondary education ICT proves to be put into action considerably less often than in primary education. Secondly, there is more variety in primary education. In primary schools, applications that are used often or quite often, are drill and practice exercises, games or adventures, problem-solving applications, and word processing. Games are often inserted as an interlude between exercises. In secondary schools, applications that are used (quite) frequently, are word processing and drill and practice exercises. It is striking that the use of problem-solving applications proved to be almost absent in classes we observed in secondary schools.

Overall, in primary schools the use of ICT appears to be integrated in daily teaching practice to a larger extent than in secondary schools. In secondary schools, the use of ICT is often restricted to specific classes as well as specific subjects (of which ‘informatics’ is the most prominent).

Innovative approaches

Innovative approaches show the use of ICT for enhancing creativity (e.g. writing texts, producing pieces of work, graphs, or drawings), for the gathering and adapting of information, for simulation of real life activities, or for stimulating social processes. In these settings pupils in general know what they are expected to do and they are largely working on their own or in pairs at the computer. This leaves the teacher as a coach and facilitator, who monitors the pupils’ progress in the background, and stimulates pupils to solve problems themselves or in co-operation with classmates. Instead of directly answering pupils’ questions or taking control of their keyboard, the teacher gives hints or clues. In this way teachers allow their pupils some degree of experimentation. Computers are looked upon as tools that facilitate the learning process rather than as ends in themselves.
Less innovative approaches

The less innovative approaches typically show the use of ICT for drill and practice exercises or for exercises in which pupils are expected to follow detailed instructions step by step. Feedback in these cases is often either absent or rather general instead of tailored to the pupils' needs. Several teachers appreciate this kind of ICT use, since these applications automate time-consuming activities, thus leaving time for the teacher to give more attention to pupils who need extra help.

5.4 The role of the teacher in ICT learning environments

The role of the teacher in ICT enhanced learning environments may be affected in several respects.

Setting goals

Educational theorists who are adhering to constructivist views, promote open-ended, pupil-centred learning environments in which pupils decide to a large extent what, when, and how learning will occur. The classroom observations show some innovative approaches of ICT in which pupils indeed have the opportunity to decide to a certain extent what activities they will carry out. However, the goals for the lessons that were observed were always set by the teachers. Apart from this, several applications of ICT that were observed should be characterized as structured rather than as open-ended, thus contributing more to behaviourist than to constructivist ideas.

From some studies the conclusion may be drawn that teachers set higher standards for pupils using ICT, as compared to students who do not use ICT. With regard to this aspect, the case-studies do not provide much information, because there were no comparison groups working without ICT. In the classes that were observed, all pupils in general were expected to carry out the same activities with ICT. In case there was not enough equipment available for all pupils to work with ICT simultaneously, a rotation system was utilized. From the classroom observations the conclusion may be drawn that teachers to a large extent are setting the same goals for all the pupils in the same class.

Selecting content and media

In secondary education, the curriculum in many cases is considered to hinder the increase of ICT use. School principals as well as teachers state there is not much room for ICT
use in the secondary curriculum. Thus, informatics seems to be the secondary-school subject that is primarily enhanced by the use of ICT. In primary schools the curriculum leaves more room for the application of ICT.

Many teachers in the case-study schools pointed at insufficient access to hardware as being a significant impediment to ICT use. When computers are located in a separate computer room, teachers may feel it is more difficult to integrate the computers in regular teaching practice. The use of computer rooms has to be scheduled in advance, and the duration of the ICT-related activities has to be carefully planned. On the other hand, because of lack of money as well as lack of space it is not possible to fit classrooms with lots of computers. This means just a (small) part of the pupils in a class may work with ICT simultaneously.

Another issue which is of importance with regard to the selection of content, is related to the abundance of information which becomes available when ICT is being used, especially when multimedia and communication technologies are available to pupils. Consequently, the teacher is no longer able to keep track of all the content that is available to the pupils. This means teachers have to get used to the idea that they have less control of the content that their pupils may access.

**Teaching methods and grouping of pupils**

The most notable influence of ICT use on teaching methods in classroom practice is that it brings about a shift from whole-class teaching to pupils working individually, in pairs or in small groups. In a computer room, computers are dominating the scene, so they are being used for most of the time available, thus leaving not much room for whole-class teaching. When pupils are working at a limited number of computers in the classroom, whole-class teaching would be too distracting, so in this case the pupils who are not working at the computer, in most cases also are working individually, in pairs or small groups.

The combination of teaching methods and pupil grouping when ICT-related activities are involved (see subsection 2.4.3) depends to a large extent on the number of computers available. When there is a rather large number of computers available, which in general is the case in a computer room, pupils, for a substantial part of the duration of the lesson, are working alone, in pairs or (to a lesser extent) in small groups at the computers. When the computers are located in the classroom, rotating computer use is observed frequently. In that case, pupils work individually, in pairs or in small groups for a short period of time at a limited number of computers. The rest of the class are being taught by the
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teacher, or are also working individually, in pairs or in small groups without ICT. Computer use rotates at a regular basis. Classroom observations show that working in pairs at the computers is the grouping arrangement that was noted most frequently in primary schools. In secondary schools pupils working individually were observed about as frequently as working in pairs. From the interviews the conclusion may be drawn that many teachers, especially secondary-school teachers, prefer pupils working individually at the computer. Some teachers report they have to stimulate pupils who are working collaboratively to do their share of the work instead of sitting back and watching their partners do the job. Some teachers also point out the increasing noise level when pupils are working together, which may in their opinion disturb the rest of the class.

Some innovative uses of ICT that were observed in the case-studies, show that working in groups is promoted as part of the educational strategy. In these innovative cases, the teachers pay special attention to the composition of the groups, e.g. by inviting pupils with much prior knowledge regarding the subject or task in question and pupils with little prior knowledge to sit down in the same groups.

Interaction / feedback

A majority of ICT-using teachers have the impression that using ICT results in a shift in their role, the teacher acting more as a coach than as a lecturer. A majority also feel using ICT enables them to spend more time assisting pupils who need extra attention, and it enables them to do their work more efficiently. From the classroom observations it may be concluded that innovative uses of ICT indeed show teachers who are limiting the amount of direct instructions, stimulating pupils to solve questions themselves, and providing help when necessary. These approaches of ICT use were rated to be more pupil-centred than teacher-centred. In these cases there often was more emphasis on pupils constructing knowledge than on teachers transferring knowledge. However, if the teacher is walking around the classroom, instead of lecturing, this does not necessarily mean the learning environment is pupil-centred, with an emphasis on pupils actively constructing knowledge. The pupils’ actions may be determined by the computer programs rather than by the teacher, thus leaving little room for pupil initiative. In the lessons that were attended, pupils in general were not more in control than teachers. The majority of teachers who participated in this study exactly tell their pupils what they are expected to do before they start working at the computers. The majority also regularly check how their pupils are doing while they are at the computers.

As a consequence of the shift from whole-class teaching to pupils working individually, in pairs, or in small groups, with the teacher acting as a coach, there is more teacher-pu-
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Pupil interaction. Many teachers feel this increases their job satisfaction. On the other hand, there are less favourable aspects connected to this shift. Firstly, teachers are required to give the same explanation several times, since they are addressing small groups or individual pupils instead of a whole class at the same time. Secondly, teachers report substantially more questions of a technical or procedural nature instead of questions with regard to learning content.

There were some significant differences with regard to coaching and feedback between observations in various countries. At some points the location where the observation took place (i.e., in the classroom or in the computer room) affects coaching and feedback as well, which complicates the drawing of conclusions. The Spanish teachers were walking around the classroom and coaching pupils a lot, whereas the Dutch teachers did substantially less walking around the classroom. The latter may be explained by the fact that in several primary classes in the Netherlands pupils were doing exercises autonomously, without needing any help from the teacher. Spanish teachers referred more often to ways to solve problems than teachers from other countries did. However, they also gave direct answers in response to pupils’ questions more frequently than teachers from other countries, instead of giving clues in order to stimulate the pupils to find the answers themselves. The German and Spanish teachers more often asked questions as a response to pupils’ questions than teachers from other countries, especially teachers from Belgium.

In classrooms with a limited number of computers, and rotating computer work, coaching pupils and providing feedback also (and in some cases only) applies to the pupils who are not working with computers. During lessons in computer rooms, teachers in general divided their time more equally over pupils than during lessons in classrooms.

As a consequence of the increasing amount of information which is accessible to their pupils - as mentioned before - teachers have to be able to admit they don’t have all the answers. This is a significant change in the role of the teacher, which is related to the fact they cannot view in advance all the information the pupils may access.

Differentiation

In the lessons that were observed it was quite often the case that all pupils were expected to work through the same learning content and perform the same learning activities. There were not many remedial activities, nor higher-level activities. Within the framework of drill and practice exercises, some degree of differentiation is achieved by allocating more time at the keyboard to pupils who are lagging behind their classmates.
This means that in many cases teachers do not make use of the potential of ICT to facilitate differentiation and provide education which optimally matches the characteristics of the pupils. This subscribes to the statement that ICT is often integrated in current teaching practice, instead of making use of the extra potential. As may be concluded from conversations with teachers, the adaptation of education to the pupils' needs requires a lot of attention from the teacher, thus drawing heavily on the teacher's classroom management skills.

**Evaluation / assessment**

As stated before, the majority of ICT-using teachers regularly check on their pupils during ICT-related activities. Several, mostly drills- and practice-based, applications store information about the pupils' actions and achievements in a database. Teachers may check this database after lessons have finished, in order to check the pupils' progress and in order to set goals for the next lesson. However, more advanced ICT applications in general do not store information about the pupils' actions. Monitoring the pupils' progress is more time-consuming when pupils are to a large extent in control of their own learning, which implies they are working at different tasks, at different pace, and at different levels. Another complicating factor is that it is difficult to monitor what pupils are doing when they are working at computers that are located outside the classroom, e.g. because there is not enough space inside the classroom, because there is no Internet access inside the classroom, or because pupils are carrying out an assignment at computers in the library. As a consequence of this, teachers may feel less secure about the actions that are being undertaken by their pupils, which in turn may lead to their feeling insecure about the results of the learning process.

After pupils have finished their tasks, teachers often discuss the results with individual pupils or with the whole class. In primary schools, pupils are also invited to discuss the results of their tasks with classmates quite often. In secondary schools this approach is applied considerably less often.

**Professional development**

The majority of teachers in the case-study schools who do use ICT in their classes think this has a positive impact on their professional development. Using ICT themselves and communicating with colleagues are, according to the teachers, the means that best helped them acquire skills with regard to ICT use. ICT may provide a means of enhancing the teacher's professional development, by facilitating communication with colleagues from other schools. Until now, communication from teacher to teacher in most cases is limited
to communication with colleagues from the same school. Access to the Internet provides opportunities for teachers to engage in communication by e-mail with fellow teachers all over the world. Teachers may also gather information they may use when preparing tasks or assignments for pupils, or they may gather information with regard to educational specialists’ views on ways to foster the pupils’ learning, including pedagogical and didactical issues. In this way, ICT may broaden the teacher’s horizon. However, only one out of five ICT-using teachers in the case-study schools has access to a computer at home, and the number of teachers having access to the Internet at home, is even smaller. This hampers the teachers’ opportunity for enhancing their professional development at home.

In the interviews with teachers the remark was heard several times that some pupils are better at the computer than the teacher. Teachers have to be willing to accept this, and they have to be willing to learn from their pupils with regard to the use of ICT. This seems to be one of the key issues which are separating ICT-using from non-ICT-using teachers. The non-users often report they do not use ICT since they do not feel familiar with computers. Most ICT-using teachers, on the other hand, accept that some pupils are better at the keyboard than they are themselves, and make use of this by asking these pupils to assist their fellow pupils when they are confronted with problems.

Task load / task perception

With regard to the teacher’s workload, a substantial group of ICT-using teachers in the case-study schools thinks using ICT does not lead to main differences, as compared to a situation without ICT use. One out of five ICT-using teachers feels there is a negative impact at this point. However, one out of three teachers has the impression ICT has a positive influence on the teacher’s workload. Of course the teachers’ views with regard to the impact of ICT on their workload may be influenced by the way they are actually using ICT, by their skills with regard to the use of ICT, and by their amount of experience with ICT.

Some innovative approaches require more preparation time than traditional approaches. Setting up e-mail exchanges with schools abroad takes more time than instructing pupils to do drill and practice exercises. Setting up life-like simulations (e.g. office simulations) is quite time-consuming. Introducing new ICT applications in the class at first takes some extra preparation time, just like the introduction of a new textbook does. During the lessons, innovative approaches may also require more energy from the teacher. Providing face-to-face explanation to pupils implies that a teacher has to explain the same thing several times to several pupils, which takes more time than explaining to a
whole class at the same time. Providing clues in order to guide pupils to the solution of a problem takes more time than directly giving the answer.

ICT may serve as a management tool to the teacher, facilitating the registration of pupil’s achievements (by means of pupil monitoring systems, spreadsheets or databases). Word processors, scanners and colour printers enable teachers to produce work sheets that match professional standards a lot better than cutting and copying does. Word processors also enable them to construct tests that may easily be reproduced, altered or rearranged. The majority of teachers in the case-study schools who do use ICT in their classes think ICT has a positive impact on the efficiency of their work. However, using the potential of ICT may also lead to an extra investment of time. Among time-consuming activities are checking pupils’ activities from database records and entering new goals in the database, using extended facilities of ICT with regard to pupil monitoring systems, or searching the Internet for teaching materials.

Motivation

The ICT-using teachers who took part in the survey in general have very favourable ideas about the influence of ICT on the pupils: a majority think that the pupils’ motivation is better when using ICT, that pupils show more interest in the subject, that ICT has a positive impact on the pupils’ information handling skills, as well as on their amount of concentration and involvement, that ICT leads to better learning achievements, better learning efficiency, and to an improvement of problem-solving skills, as compared to education without ICT use. These favourable views about the impact of ICT use on the pupils may be considered to have a positive impact on the teacher’s motivation as well. Approaches that require more time or energy from the teacher (with regard to classroom management, providing feedback, or preparation time), may also be more rewarding. For example, many teachers appreciate interacting with individual pupils or with small groups more than providing whole-class instruction, in spite of the extra energy it takes. Contributing to improving the quality of education may also be regarded by teachers as rewarding, which may compensate for an extra investment of time, which, moreover, in part may be of a temporary nature.

5.5 The hypotheses revisited: teacher roles in innovative ICT approaches

In subsection 2.4.8, ten hypotheses were formulated with regard to constituents of innovative ICT learning environments and with regard to the teacher’s role in these settings. These hypotheses will be addressed in this subsection, with reference to the results of
this study, in particular the qualitative observations of innovative cases of ICT-related activities in classrooms that were visited.

Although content differentiation was noted in a majority of observations of innovative approaches, the lesson content in most cases seemed only partially adapted to the pupils’ needs and abilities. It was often the case that pupil groups were allowed to choose lesson content from a limited number of options, or they were expected to master a prescribed sub-task which did not depend on the abilities of the respective pupil. This leads to the conclusion that the first hypothesis (‘lesson content is adapted to the pupils’ needs and abilities’) was only partially confirmed by this study.

In general, pupils are stimulated to be active learners in the innovative approaches that were observed, which confirms the second hypothesis. Active pupil participation is stimulated by situating the lesson content in or by referring to authentic contexts, which is the case in nine out of ten innovative approaches which were described earlier (the third hypothesis). However, in only three out of ten innovative lessons that were observed, pupils were enabled to view problems at hand from multiple perspectives. This means the fourth hypothesis is only partially confirmed.

Higher-order thinking skills are fostered in a majority of innovative cases that were viewed (the fifth hypothesis). This is aimed at by focussing on information handling and/or problem solving.

In all innovative learning environments referred to, co-operative learning is stimulated. Pupils are grouped in pairs or small groups. Apart from this, several teachers paid extra attention to the group composition, in order to foster pupils aiding their fellow pupils. This confirms the sixth hypothesis.

In all these innovative cases, teachers were acting as coaches instead of as lecturers. Most of them were walking around the classroom, monitoring pupils’ activities, and responding to pupils’ questions. Whole-class teaching was either absent, or just served the purpose of introducing the activities that were to be performed. Thus, the seventh hypothesis may be confirmed. The eighth hypothesis (‘teachers give hints and clues rather than direct answers’), may to a large part be confirmed: six out of ten teachers consistently provided pupils with hints and clues rather than direct answers. However, the hypothesis that teachers have less control of the lesson content in these ICT learning environments was not confirmed by most of our observations in innovative settings. Obviously, teachers were in control of the lesson content, which was supported by the
limited amount of content differentiation and the rather limited amount of information available to pupils in most cases.

The tenth hypothesis, regarding the availability of diagnostic and evaluation ICT instruments could not be confirmed. In our observations we did not meet any teaching situations in which these kinds of instruments were used.

Summarizing, the innovative uses of ICT that were viewed within the framework of this study, and which represented a minority of the total of observations made, did not show all characteristics of innovative, pupil-centred learning environments. Based on our experiences in educational practice, we can conclude that, in spite of the progress made, much remains to be done to promote pupil-centred uses of ICT in education.

5.6 Towards optimal education with ICT

ICT provides opportunities to enhance new learning environments, which are more tailored to current and future needs in education. There are two main reasons for creating these new learning environments. Firstly, the emerging of the ‘information society’ calls for new skills, especially with regard to information handling. Secondly, there is the problem that school learning which is abstracted from reality may lead to ‘inert knowledge’, which is not likely to be used in situations outside the school. New learning environments should be created that stimulate pupils to process information autonomously and to actively construct knowledge, the teacher being a facilitator of this process. ICT may serve as a valuable tool in these new learning environments, e.g. by providing an abundance of information resources, by providing simulations of real situations, and by providing tailored feedback.

However, as this study shows, these new learning environments in which pupils are actively constructing knowledge, are still a rare phenomenon in education, even in the ‘technology-rich schools’ that were selected for the empirical part of this study. Although several innovative uses of ICT were reported from the classroom observations, computers are also often used as tools to ‘automate’ exercises, or as tools to facilitate the writing of texts. The use of ICT for the gathering of information, for problem solving, simulations, etc. is employed by a minority of teachers. In this respect, the findings of other studies, i.e. computers are used mainly to complement rather than change existing pedagogical practice, are confirmed by this study. As a consequence of this, the opportunities ICT provides to facilitate differentiation, in many cases remain unused.
Guidelines towards optimal education

From pedagogical and educational points of view, the learning environment should be designed as optimally as possible to stimulate the continuous interaction with the child’s characteristics from the entry of kindergarten onwards. Given the differences between children, the goal is to find out how this stimulation of development and learning processes can be realized for all pupils. Different requirements seem at stake. Below, five guidelines are described which have to be effectuated in order to create optimal education. These guidelines have provided a basis for the evaluation of schools’ actions with regard to the use of ICT, within the framework of an on-going large-scale ICT stimulation project from the Dutch government (Mooij, Smeets, De Jong, Selten, & Dousma, 1998). It is assumed that, once these five guidelines have been implemented, every pupil can realize his or her full potential in kindergarten and further on in education, because the curricular play and learning processes are designed in such ways that the corresponding social, emotional, sensorimotor, cognitive, creative, and instructional aspects both reflect and stimulate the characteristics of the pupils actually present. For this reason, the result of these guidelines can be conceptualized as ‘pupil-based education’. This concept defines optimal education, i.e. education without e.g. negative selection that causes system-based demotivation effects with pupils.

1) Pedagogical and social aspects should foster active, autonomous learning.

Attention should be paid to pedagogical and social aspects of the group situation in classes. Pedagogically, the educational situation should promote the harmonious growth and stimulation of every learner on all relevant aspects, e.g. cognitive, social, emotional, creative, athletic or sensorimotor, and motivational characteristics. A class with about 25 or 30 young children requires a lot, and now and then too much, of the teacher. Giving more social and didactic responsibilities to pupils themselves is one of the potential solutions (Alschuler, 1980; Mooij, Selten, & Smeets, 1998).

2) Educational content should be based on each pupil’s entry characteristics or entrance level.

Optimal educational practice should start at the moment a child starts early childhood education, e.g. kindergarten. This beholds that, at the beginning of kindergarten, parents and teachers should inform each other as accurately and simply as possible about relevant entry behaviours of a child (cf. Mooij & Smeets, 1996; Walker et al., 1998). Such an intake procedure can also result in entrance indicators relevant to the start of the pupil’s school career. Relevant behaviours and differences in developmental functioning
of the pupils in a kindergarten class should be used as the basics for part of the play and
didactic learning characteristics in the class. With respect to early childhood education
Pellegrini and Boyd (1993) think it is necessary to match play-oriented curricula with
children’s developmental status in order to provide guidance for developmentally ap­
propriate practice. They, moreover, emphasize the values of play for ‘learning practices’
in primary school and state that play, in an ecologically valid situation, is an excellent
medium to evaluate children.

3) **Distinguish non-structured as well as structured learning contents.**

Baroody (1993) and Mooij (1995) suggest that instructional lines could support the
stimulation and integration of a child in kindergarten and elementary and secondary
school. The concept of ‘instructional line’ is used by Mooij (1999a, 1999b) to denote a
hierarchical arrangement of educational concepts and subconcepts that correspond to
specific play or curricular and instructional materials. For children developing slowly,
the materials should refer to remedial activities. For children gifted in a certain aspect,
the play and didactic materials should be situated on a much higher level, requiring more
self-regulation and co-operation in small groups. The playing or working along
instructional lines should allow and stimulate self-responsibility, self-evaluation and self­
registration of pupils.

4) **Evaluate the pupils’ progress on a regular basis.**

The pupils’ progress with regard to cognitive as well as social aspects should be assessed
regularly, in order to discover whether the provision of learning content should be
altered.

5) **Characteristics of the educational content should be evaluated with respect to their
contribution to the pupils’ progress on a regular basis.**

Quality indicators and processes are necessary to evaluate or judge educational processes
and their outcomes on every learner, from the beginning in kindergarten onwards. For
example, Tymms, Merrell and Henderson (1997) noted huge differences between
kindergarten effects on four-year-olds already. This also means that specific norms
should be available regarding the development of learners and the characteristics of the
educational situations, including the didactic and curricular integration of ICT in
educational practice. Such continuous quality control and improvement seems very
important, in particular for pupils at-risk from a very young age onwards.
Integrating ICT in pupil-based education

The implementation experiences with pupil-based education clarify that ICT can lend an important hand to the possibilities to develop pupil-based education as a system stimulating all pupils, in particular the pupils most deviating from their age mates (cf. Mooij, 1998, 1999a, 1999b; Mooij et al., 1998). Given the potentials of ICT to support optimal education, it can be expected that integration of ICT in pupil-based education will lead to an exponential increase in improvement of education. Some examples will be given.

A pupil’s positioning within an instructional line can be based on the relevant beginning characteristics of four-year-old pupils in kindergarten (cf. Mooij, 1997b). A prototype of a computer program is being developed to support both pupils and teachers in kindergarten and the first years in elementary school. The instructional lines consist of different educational contents. In the present program prototype, the contents refer to motor behaviour, social-emotional development, projects, Dutch language, (preliminary) arithmetic, (preliminary) reading, and (preliminary) writing. Activities or tasks within each line are visually represented by a photograph of the material object as present in the class, because four-year-olds must be able to work with the program. The photographs are sorted by difficulty level. The numbers of photographs within a line differ, depending on the circumstances. To be able to stimulate pupils adequately, some of the same content lines refer to developmental levels of pupils e.g. regularly developing pupils, pupils who need remedial activities, and pupils who are advanced on the topic of the line. Depending on their progress, pupils can switch to another line.

The program prototype also acts like a planning system for both pupils and teacher. The teacher can assign an instructional line, or specific line contents or tasks, to every pupil separately, or to a small group of two or more pupils. Different kinds of colours and icons are used to make the program understandable for four-year-olds. By using the program, every pupil in a kindergarten class can check the play or instructional alternatives she or he has been given by the teacher. The pupil has relative freedom where it concerns choosing a certain play activity; where it concerns an instructional line, the content and kind of line, the entry level, the progress in the course of time, and the kind of evaluation are regulated by the program.

The teacher can change or extend the play activities or instructional lines in the program, to improve the educational processes or their desired effects for one or more pupils. She or he can also get overviews or summaries of the lines included, the pupils involved, or
the pupils scheduled for certain activities. Moreover, overviews of the progress of every pupil, or a group of pupils, can be produced.

The program thus also functions as a registration, monitoring and management system, e.g. for evaluation purposes. Because of its flexibility to teachers’ use and goals in school, it seems basic to the further development of optimal education including ICT. The implementation of this prototype required preparatory work, which became also clear in desired changes in educational practice in kindergarten and elementary education (cf. Mooij, 1997b, 1998).

In optimal education pro-social processes should be realized in collaboration between kindergarten and school, the pupils, and the parents or caretakers. ICT may play a facilitating role at this point, as well. Accurate information about the social processes between the pupils, between the pupils and the teachers, and at home, can easily be collected and evaluated by using a computer program (Mooij, Mooij, & Smeets, 1997). With nine- to fifteen-year-olds in elementary and secondary education, this program measures the type and amount of pro- and antisocial behaviour, e.g. being a victim and being a perpetrator of bullying, the places where the behaviour occurs (at school, outside school, at home), as well as actions taken against antisocial behaviour. The program is completed anonymously by all the pupils in class. The results are recorded and percentages can be compared per class and over a number of classes, both cross-sectionally and longitudinally. Pupils, or pupils and teacher, can make agreements to reduce degrees of antisocial behaviour in the future. In this way pupils are given responsibility with respect to their own pro-social behaviour, which seems very important from a pedagogical point of view (Deutsch, 1993). If the program is completed on a regular basis, e.g. once within each quarter of a year, the pupils’ self-evaluation may show progress in a pro-social direction, which can stimulate the pro-social improvement for the next measurement.

Quality criteria using ICT

Using entry-level characteristics, e.g. in kindergarten, as the initial indicators for a pupil’s levels of development, subsequent indicators can be integrated within instructional lines throughout elementary and secondary education. The progress over the course of time, relevant diagnostic aspects, and further relevant information, e.g. about the pupil’s physics or home situation, could be included in the further development of the prototype program described above. Experiences in educational practice show that many uncertainties and wrong decisions about pupils are caused by a lack of such information over the course of years (cf. Mooij, 1991, 1999a). Moreover, using these
kinds of quality criteria in supporting a pupil's school career has many advantages in comparison with the present use of age-related norming. In this way, ICT may facilitate the abolishing of the year group system.

5.7 Recommendations

As a conclusion of this study, several recommendations may be formulated with respect to several aspects of the impact of ICT on the role of the teacher. Meeting these recommendations may stimulate the implementation of ICT in education to a larger extent than is the case at this moment, and it may stimulate the use of ICT in innovative approaches, eventually leading towards optimal education.

Enhancing teachers' beliefs and skills

One of the findings from this study is that pre-service as well as in-service teacher training is often considered to fall short with regard to the attention for the didactic potential of ICT. Teachers get to know the potential of ICT for education mainly by using ICT themselves and by communicating with colleagues about ICT. This leads to the following recommendations:

1) Teacher training should address the use of ICT to enhance educational practice, instead of focussing on technical aspects of ICT use (like the use of operating systems, word processors, and so on). The added value of ICT should be made explicit to teachers.

2) Communication about ICT with colleagues inside the school as well as with colleagues from other schools should be stimulated. This may be done by organizing seminars with regard to applications of ICT in educational practice, scheduling discussion about ICT at teacher meetings, stimulating cross-curricular projects, seeking contact with other schools (e.g. via e-mail), and setting up Internet discussion groups with regard to education.

3) Teachers need access to technology at school in properly equipped study and practice rooms, so they can get acquainted with educational software. Apart from this, they also need access to computers to search for and prepare learning materials, and keep track of pupils’ achievements.

4) The use of ICT by teachers should be stimulated by providing relevant information, downloadable demo versions of software, lesson plans, etc. via the Internet.
5) The availability of computer equipment, Internet access, and e-mail for teachers at home should be stimulated, so teachers have access to technology outside the school building.

Meeting preconditions with regard to ICT

Several preconditions have to be met in order to enable teachers to successfully integrate ICT in their teaching practice:

6) There has to be sufficient access to ICT equipment. This means there should be enough hardware available, and the equipment should not be outdated. If the equipment is situated in a computer room, there should be sufficient opportunities for teachers to schedule lessons in that room.

7) Teachers using ICT should be supported by an ICT co-ordinator and a system operator.

8) The school management should allocate budgets for the purchase of educational software.

9) There has to be sufficient and adequate educational software available, and teachers should be informed about the range of products. In general, software which is linked to the regular teaching materials is more likely to be used than isolated applications. However, teachers who do not use textbooks in general prefer software which is not linked to a textbook.

10) There has to be enough space for ICT-related activities for pupils in the school building. Enhancing active and autonomous learning requires that pupils have access to properly equipped individual places for study outside the classroom, to which they have access during as well as after lessons.

Strengthening the position of ICT

In many cases the question whether or not ICT will be used in the classroom depends on the decision of the individual teacher. Apart from this, the use of ICT may be restricted because - especially in secondary schools - teachers feel the curriculum does not provide enough room for ICT-related activities. The position of ICT may be strengthened by the following measures:

11) The use of ICT by teachers should be stimulated by the school management, e.g. by encouraging teachers to attend training with regard to ICT, by imposing the use of ICT for keeping records of achievement, or by introducing pupil monitoring systems that use ICT.
12) Adding certain ICT-related activities to the curriculum as well as adding certain skills with regard to the use of ICT to the examination requirements will stimulate the development of educational software as well as the use of ICT in educational practice.

Creating optimal education

To prevent ICT from just being integrated in traditional teaching practice, optimal education should be promoted. In this respect, ICT may play a supporting role. Meeting the following five guidelines is crucial with regard to optimizing educational practice:

13) Attention should be paid to pedagogical and social aspects of the group situation in classes. Pedagogically, the educational situation should promote the harmonious growth and stimulation of every learner on all relevant aspects. Pupils should be given more social and didactic responsibilities.

14) Educational content should be based on each pupil’s entry characteristics or entrance level.

15) Within the learning content, a non-structured as well as a structured part should be distinguished.

16) The pupils’ progress should be evaluated on a regular basis.

17) Characteristics of the educational content should be evaluated with respect to their contribution to the pupils’ progress on a regular basis.
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References


Annex 1 - Overview of project partners

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Annex 2 - Overview of participating schools

Belgium

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Spain

Cooperacion Magòria  primary education
Institucion Montserrat  prim.+second. education
Escoles Pies de Sarrió  prim.+second. education
Liceo Egara  prim.+second. education
Proa  prim.+second. education
Annex 3 - The case studies: results from the interviews with school principals and ICT co-ordinators

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1 Belgium

Resources and support for ICT

The principals of all schools agree that when you consider ICT as a priority, you can buy ICT-equipment within the regular working budget. For some schools this seems to be more easy than for others. The reason for this may be on the one hand a matter of subjective feelings and on the other the general financial situation, which depends on different factors, such as the history of the school, the governing body, and support by parents. In three of these five schools the parents’ association organizes special events for collecting money in order to finance ICT-equipment. In the primary 'method'-school several parents provide technical and practical support.

Each of these schools participates in one or more ICT projects, which are funded by the Flemish Government or the European Community, sometimes in cooperation with private institutions or enterprises. Although there are some complaints about these projects (e.g. with regard to pre-financing, liberty to spend the money, administrative problems), all schools agree they benefit from these projects as regards contents (e.g. international partnerships), equipment and ICT-applications.

There seems to be no real offer in appropriate ICT in-service training. In each school, introductory sessions and workshops with regard to ICT are organized. These activities are organized and lead by one of the competent teachers with regard to ICT of the school. Starting this school year, in two of these schools one teacher is excused for a part
of his/her job thanks to funding by the organization of Catholic schools in Flanders, in order to organize in-service training.

None of the schools have an appointed official ICT co-ordinator. It is always the personal initiative of a teacher to do something extra with regard to ICT (writing and elaborating projects, the maintenance of the computers, the organization with regard to the occupation rate of computer classrooms, etc.). All the principals consider it their duty to offer their teachers all opportunities they need and to stimulate them. None of the principals think you can force teachers to work with ICT, since teachers need time and opportunities to explore the new media and to experiment. In three of the five schools the principal, together with one or more teachers, is the broker concerning ICT-use. In the ‘method’-school it is one of the teachers who considers everything with regard to ICT in the school as part of his job. In the other school it is a language-teacher who stimulates other teachers (mainly language-teachers) to use it as well. In each school informal core-groups or working groups with regard to ICT are formed, though not formalised. They are formed by teachers with a special personal interest in ICT.

The only external organization of great benefit with regard to supporting ICT in the schools is the SIP (‘Scholen Informatica en Internet Project’ or ‘Schools Informatics and Internet Project’). This seems to be a worthwhile supportive organization that organizes in-service-training, provides information about all the innovations, gives personal advice, and has some equipment (e.g. a digital camera) that can be get on loan. This organization, however, is only active in one province of Flanders.

**Use of ICT in teaching**

In general the principals do not have a clear view of the extent to which ICT is used by teachers in their schools. It is clear that there is a huge diversity, because the teachers are free to decide whether or not to use ICT. Only in the primary schools, nearly all the teachers (of the primary section, in one school also of the nursery section) use ICT in their classes. In the secondary schools the use of ICT is concentrated in the higher grades. An important reason for this is the restricted number of available computers. In general ICT is used for all kind of subjects, depending on the teacher’s preference. In the secondary schools, ‘languages’ seem to have a slight edge over sciences. In none of the curricula, except for ‘informatics’, the use of ICT is inscribed but there is the perception that in language curricula there is more space for ICT than in the overloaded curricula of some other subjects.
Inside each school there is a great variety in ways of using ICT, e.g. as game, drill and practice, communication tool, information source and remediation tool. Like the extent of ICT use, the approach also highly depends on the personal initiative of the teachers. In general, the pupils work in small groups (2-3) at the computer.

In the secondary schools the whole class often uses ICT simultaneously, while in the primary schools this is the case with just a part of the class. In the primary schools a more differential pattern of grouping is used. In most of the primary school classes the computer is used in an integrated way (computers are located in or near the classroom), while in the secondary schools there are separate computer classrooms and separate lessons during which ICT is used.

In all the schools, pupils are allowed to work or to play with the computers after the school hours. They can send e-mail messages, chat, search for information on the Internet, make some remedial exercises, etc.

Effects of using ICT in the school

According to the school principals, ICT provides opportunities for more individualization, especially in primary schools. The tasks and assignments can be adapted to the individual pupil, whereas the teacher has more control of the progression of each pupil.

If the software gives the correct answers, the pupils can work more independently. Using ICT in the sense that the pupils work with it independently can difficultly be combined with whole-class teaching. So the pupils work individually or in small groups on a task and are continuously busy, active.

Communication between teachers, between pupils, and between pupils and teachers is stimulated by ICT. The use or the introduction of ICT forces the teachers to think about and to consider as well long-term aims and objectives of education. These issues can be discussed with colleagues within the schools, as well as with colleagues in other schools. When the pupils work in pairs or small groups they are forced to discuss their actions, to argue what they want to do and why they want to do this, and to report their findings. They discuss strategies to come to a result. The principals do not have the impression that ICT strongly influences the pupil-teacher relationship. When teachers and pupils work together on a project, however, they get to know each other better. Apart from this, some teachers experience they can learn from their pupils, since pupils often know more about ICT than their teachers.
All the principals mention the fact the pupils learn how to handle a computer and they perceive it to be a necessary skill for further education and professional life. All the principals are convinced that pupils are more motivated when they may use the computer, they experience more active involvement.

The Internet is a huge information source. So the number of subjects or topics about which pupils or teachers have difficulties to get information is reduced. Difficult concepts or processes can clearly be shown on a central presentation screen. As a consequence, pupils can see a visual representation and thus understand it more easily.

Nearly all the principals mention that the teacher becomes more a coach, who supports the learning process. They also mention that the computer will become more and more part of the classroom and that this is a growing process. Pupils function as stimulators of their teachers. Some teachers already changed their way of teaching but others did not (yet). According to some principals, they will be forced to change after a couple of years.

*Obstacles to using ICT*

Obstacles to using ICT, as mentioned by the school principals, refer to knowledge, time, finances, attitudes of teachers, software, and the curricula.

First of all, many teachers have insufficient knowledge of the possibilities ICT offers. All principals complain about the lack of focus on ICT and on more individual teaching in the teacher colleges. They all agree that in order to give innovations a real chance, teacher colleges will have to start training young teachers in these innovations. In general, there is also a lack of appropriate high quality ICT in-service training. Several teachers do not use a computer themselves, so they are not at all familiar with a computer. One of the principals argues that in order to stimulate the ICT use in education a good strategy would be to financially stimulate the purchase of a computer at home by teachers. Another factor that is important at this point, is time. The teachers need time to explore the new media before they can use them in the classroom.

A lack of technical know-how in the schools seems a really important obstacle. The technical aspects of ICT are not that simple and all the equipment needs maintenance. Until now, in each of these schools this is done by a teacher or member of the administrative staff who is interested in it and is willing to perform these tasks in addition to his job voluntarily. For schools which do not have such a person it is nearly impossible to work with ICT. In order to be able to make decisions about which software
to purchase or how to use it in the classroom, teachers also need basic technical know-how which is, however, often problematic.

Finances are especially required for the purchase of more hardware. Each of the schools could use more computers. However, principals of secondary schools say that the lack of a sufficient number of computers is often used by the teachers as an excuse for not using ICT. Teachers in the secondary schools complain that they have to switch from classroom to computer classroom in order to be able to use ICT. The purchase of central presentation screens is very expensive but according to the principals of the secondary schools it is necessary for an effective use of ICT.

The attitude of teachers is an important factor as well. Most of the teachers are very busy and do not find the time to explore new media. Before they really see the added value of these media, they do not want to spend time on them, which leads to a catch 22. Because some teachers are not familiar with computers, they do not feel secure enough to use it in the classroom. Some are also afraid of having a lot of disorder during their lessons.

A lack of suitable high quality software is seen as an obstacle by all the principals. In the secondary schools, the curricula are considered to hinder the increase of ICT use. Most of the curricula are already overloaded and consequently there seems to be no space to do something in addition. The lack of appropriate software is connected to this problem. In none of the curricula, except for informatics, ICT-use is referred to.

2 Germany

Resources and support for ICT

One of the primary schools is equipped with 12 computers, 8 of which are installed in a computer room (IBM PCs), the other school is equipped with 9 computers, which are distributed over the classrooms. Many of the primary schools’ computers were received from parents or from enterprises. Some have been obtained at special prices.

Interestingly, there were great differences in the handling of ICT resources in these two primary schools. In one school, there was hardly any support for teachers who wanted to use ICT in their classroom, while in the other school, there is a platform where teachers can discuss ICT related problems, and where they also receive additional training.
Between the secondary schools, there are no large differences with respect to the student/computer ratio. HS is provided with 14 PCs in a computer room, RS has 15 PCs in its computer room, while G is provided with 35 PCs, 25 of which may be used in classrooms. The majority of the computers were given to the schools by the respective communities.

Two of the schools (RS and G) were participating in the project ‘Connect schools to the Net’ (‘Schulen ans Netz’) which is supported by the Federal German Government and a number of private enterprises which help schools get connected to the Internet. The project also provides for additional training of the teachers and offers a platform for exchanging ideas on the use of ICT in the classroom.

There is some variation with respect to the principal’s role in supporting ICT related activities in the secondary schools. In one school, the principal himself is organizing and offering courses on computer use; he is promoting the use of ICT to a large extent. In the other two schools, the principals do play a role in the promotion of ICT, but they are less active. In all three schools, teachers may take part in ICT training sessions during their regular working hours.

Use of ICT in the school in teaching

Although the primary curriculum does not explicitly provide for the use of ICT in specific subjects, it also does not enumerate any restrictions. Therefore, each teacher may use ICT as he deems appropriate.

As for the primary schools, the use of ICT in secondary education is not restricted by the curriculum (nor is it explicitly warranted). The initiative to use ICT may come from specific persons, but it seems that each teacher may use ICT if he so wishes. Subjects in which ICT is used are primarily informatics (HS, RS, G), word processing (HS), use of the computer (HS, RS), and use of the Internet (RS, G). All these courses are offered to 10th and 11th graders (except for the use of computers course in HS, which is offered to 5th graders). There were no indications that ICT was used in any other subject.

Effects of using ICT in the school

At primary school level, ICT is used in different subjects. The main advantage in using ICT seems to be the motivating effect it has on the students. The use of ICT is also considered to help differentiate teaching, i.e. tune it to the needs of the individual student and improve the communication between students and teachers.
The use of ICT in secondary schools seems to be much more limited to a single subject: informatics. Nonetheless, principals feel that the use of ICT will have a motivating effect on students, particularly on underachieving students. It is also assumed that the use of ICT will increase a feeling of responsibility on the part of the student for his learning activities.

Obstacles to using ICT

The main obstacle to the use of ICT in primary schools seems to be the lack of money for buying appropriate hard- and software. Also, opportunities for ICT related training are scarce, and teachers are given too little time to acquire knowledge with respect to the use of ICT.

At secondary school level, the situation seems to be somewhat different. There are complaints about there being hardly any maintenance of the hardware, about PCs being unavailable at times, and about the fact that teachers using ICT in general do not have much experience in this field. There is also the complaint that the procedures to obtain financial help from the project ‘Connect Schools to the Net’ are not well defined. At the same time, it is argued that many of the problems might be overcome if schools tried harder and looked for more creative solutions.

3 Ireland

The case studies in the Irish part of the study were undertaken in four primary schools and one secondary school. In each school, interviews were undertaken with school principals, but in all cases the ICT co-ordinator was interviewed at the same time, or separately.

Resources and support for ICT

All the schools had designated computer rooms. In the 4 primary schools, there were 18 Acorn Computers, 17 Apple Macs, 23 PCs. In the second level school there were 13 Apple Macs and 10 PCs.

In three of the four primary schools the computers and software had to be purchased from fund-raising activities by the schools - which directly or indirectly means from the parents. They also have to draw from their own budgets, which means making cut-backs in other areas. In the case of the primary school in a disadvantaged area the school won
the Siemens/Nixdorf Centre of Excellence in Computing Award and part of their prize were 10 multimedia computers. In addition in 1996 the Department of Education provided £3,000 for purchase of ICT equipment – ‘the first and last help’ they gave the school for ICT. The high level of unemployment in poverty in the school’s catchment area means that fund-raising from the local community is not feasible.

In the case of the second level school the local Vocational Educational Committee (essentially the only form of local education authority in Ireland) provided funding for the computers. Here, the attitude and disposition of the Chief Executive Officer of the VEC was a critical factor.

In all five schools there is a de facto ICT co-ordinator. In one of the primary schools the principal has arranged things so that the teacher who is the ICT co-ordinator has ICT co-ordination as her main responsibility. However, the ICT co-ordination role is only formally recognised (i.e. notified to and sanctioned by Vocational Education Committee) as a ‘position of responsibility’ in the second level school.

Training generally happens in an informal way through and depends on the willingness and commitment of the ICT co-ordinator to help his or her colleagues. This training has usually taken place outside school hours. There is no in-service training in ICT provided by the Department of Education and no financial support for training in ICT from the Department either.

Two of the primary schools had a written development plan for the use of ICT in the school.

Two of the primary schools were able to avail of teaching assistants employed on a Community Employment Scheme basis to help with activity in the computer room. The degree of contact and the opportunities for contact between teachers and schools using ICT are largely down to individual teachers taking the initiative.
Use of ICT in the school in teaching

In all the primary schools computers were first introduced in the early to mid-1980s. In general BBC Micro computers, Acorn computers or Apple Macs were preferred to PCs, as at that time the MS-DOS based software was not child-friendly. For Acorn computers educational software related to the English primary school curriculum was available. PCs only began to be introduced since the advent of Windows 95 and the availability of CD-ROM based multimedia titles.

In the secondary school, which was established in the 1990s, the first computers purchased were Apple Macs with PCs only being acquired in the last year or two. In all cases the initiative to use computers in teaching has come from teachers within the schools. In the primary schools the philosophy underlying use of computers is that they must be seen as tools for learning. ICT use should complement and supplement what happens in the classroom and thereby be integrated into the curriculum. In the primary schools, teachers and ICT co-ordinators were at pains to make clear they did not want to teach ‘computing’.

The role of the principal, except in one primary school, has been to act as facilitator and support for the ICT co-ordinator.

In at least two cases, the ICT co-ordinators said that attempts in the past to introduce teachers to computers by people coming from a computing rather than a teaching background were disastrous. Training of teachers in the ICT in schools has to focus on the ‘why’ rather than on the ‘how’. If this is done even older teachers ‘get hooked’.

In the secondary school the rationale for use of ICT is somewhat different. Here the focus is more on the instrumental/vocational aspects of computing that can be related to labour market needs. The model of computing and the software in use reflects what is happening in the business environment. Because teachers have different subject areas and because the curriculum is so exam orientated, there appears to be less scope for a coordinated approach to use of ICT by the teachers as a whole.

In all the schools use of computers takes place mainly in the computer room rather than in the classroom. Sessions in the computer room are time tabled for classes.

In the primary schools all classes have some opportunity to use ICT. No particular pupils or set of pupils are targeted. However, several teachers report that the use of ICT can be
particular benefit to pupils in Special Classes (i.e. Remedial classes for pupils with learning difficulties.)

In the primary schools almost all the teachers were using ICT in teaching to some degree. This is probably made possible by the nature of the primary school curriculum, which allows the use of ICT to be integrated into classroom activities. The activity in the computer room is sometimes continuing an activity that began in the classroom – e.g. word-processing – writing letters, articles. ‘We don’t see it as taking time out but as a linkage to the general curriculum.’ In the upper classes of primary schools the trend is towards using content free software.

In the primary schools a conscious effort has been made to mix academically able with less academically able students in computing activities.

In the secondary school, due to the constraints imposed by the curriculum, use of ICT has been confined to pupils in Transition Year (4th Year) which comes between the three years of the Junior Cycle leading to the Junior Certificate examination and the two years leading to the Leaving Certificate examination.

*Effects of using ICT in the school*

In all cases pupils are highly motivated to use computers. They look forward to their sessions in the computer room. Crucially, pupils can learn without even realising it. The fact that the software can be set at different levels of difficulty and that pupils can set their own pace of learning is a real benefit.

It has been found that for pupils with learning difficulties, or pupils with undeveloped social skills computers can open learning opportunities.

Some equality or parity of esteem is introduced among pupils when they can see their work in a printed out form.

Collaboration between pupils using computers is an important benefit. In a wider sense, using e-mail, contact is established with other schools and pupils. This opens up lots of opportunities to pupils for finding out not only about other countries but also about their own neighbourhood.
**Obstacles to using ICT**

Overall, the lack of coherent policy or vision for the use of ICT in schools presents a problem.

Support from the Department of Education in terms of funding for computers or other ICT equipment is almost non-existent. There is virtually no in-service training provided for teachers in the use of ICT in teaching.

The cost of acquiring licensed software is an obstacle where software is not provided with the computers. There is no organized or discounted scheme for schools. There is very little Irish language software available.

Inflexibility of the mainstream curriculum at secondary level means there is very little scope for the introduction of ICT in teaching, apart from Transition Year classes.

The age of teachers has not been a barrier. Older teachers can adopt as well as younger ones given the appropriate training and rationale for the use of ICT.

**4 The Netherlands**

*Resources and support for ICT*

In the three primary schools there are no computer rooms; the computers are located inside the classrooms or near the classrooms (in the corridor). In schools A and B there is one computer in the classrooms of the younger pupils, whereas for the higher grades there are two computers in or near each classroom. In school B there is also a CD-I player. In school A pupils may also use the computer in the teachers' room. Both schools have e-mail facilities, which may be used by pupils. There isn't much budget for ICT, so the schools have to be creative in order to acquire the desired equipment. Some money is earned by collecting old papers. Apart from this, schools are trying to obtain second-hand computers from companies, and parents collect money by organizing a jumble sale once a year. One of the schools gained a multimedia computer in a contest. The other school managed to get a free Internet connection from a provider. In school C, there are 200 quite ancient Apple computers in a local area network. In or near each classroom four computers are available, whereas several computers are available at various spots in the school. The school started using Apple in 1984, and kept on using these machines when the Dutch government decided the IBM PC would become the
national standard (in 1987). The ICT co-ordinator has several contacts in the business world. In this way he acquires old and sometimes defective computers, which he repairs. A new network will be installed this year, enabling the school to work multi-platform. The school has been saving money for ten years for this network. The school is connected to the Internet, but pupils can’t use this connection (except for e-mail) because it is too expensive.

In these three primary schools the principals and ICT co-ordinators are not very enthusiastic about the in-service training and external support with regard to ICT. Courses that are provided by the local support institutions or teacher training colleges are considered to be too general, and not tailored to the needs of the teachers. In several interviews it was mentioned that there is not enough expertise in the support institutions to support schools that are advanced in ICT use. Special training from computer companies is too expensive. This means the ICT co-ordinators have to put in a lot of effort to get things running and to help teachers acquire skills in ICT use. In these three schools the ICT co-ordinator is charged with the training of teachers. There is hardly any time during working hours for in-service training.

In the primary schools, the ICT co-ordinator promotes the use of ICT. In the smaller schools, the amount of time available for ICT co-ordination is just a few hours a week. In school C there is a part-time ICT co-ordinator who has no teaching assignment. There are written development plans, and there is communication with the teachers about ICT on a regular basis. In schools A and B the principal acts as a facilitator. In school C the ICT co-ordinator is actually in charge of the ICT related activities.

As mentioned earlier, both combined secondary schools resulted from amalgamation processes during recent years. School D has four locations, one of them being in a village in the vicinity. School E has three locations, one of these also being situated in a village. The number of computers in school D is 140, whereas in school E it is 60. Most of the equipment is installed in computer rooms (in local area networks). Both schools also have a special office simulation classroom, which is used for preparing pupils of junior vocational education for an administrative professional career. Both schools have Internet access. In school E, pupils of the higher grades of senior secondary general education and pre-university education may use the Internet connection autonomously. The other pupils may use it under supervision. In school B, neither teachers nor pupils may use the Internet connection. Part of the computers are furnished by sponsors: companies or banks who donate computers that have been replaced by new equipment. In one of these schools, the equipment as well as the desks in the office simulation classroom were supplied by a sponsor. Schools do not have enough budget to replace
The Impact of Information and Communication Technology on the Teacher

According to the collective agreement with regard to teachers in secondary education, 10 percent of the teacher’s task is available for in-service training. However, this does not mean every teacher opts for ICT training. In school D, room for training is created by adapting the timetable when necessary. In both schools, part of the training of teachers in using ICT is performed by members of the school staff (e.g. teachers or secretaries give instruction in word processing or familiarizing with PCs). Subject specific training is available from a college of higher professional education and from national educational support institutions. In school D, the vice-principal is very satisfied with the training from one of these support institutions. In school E, not many teachers took part in subject specific training until now.

In both schools, ICT co-ordination is part of the task of a vice-principal. Apart from this, both schools have a system operator (4 and 2.5 days a week respectively, which in both cases is considered insufficient). In school D there is an ICT study group, and there is a written development plan for the use of ICT in the school. There are no structural teacher consultations with regard to ICT. The purchase of software largely comes down to the initiative of individual teachers.

Use of ICT in the school in teaching

In the primary schools, ICT is often used for exercises and remediation (mainly language training and arithmetic). While pupils in the class are working individually or in small groups, pupils are working individually for a short period at the computer. This typically takes five to ten minutes per pupil, and after that the next pupil is called. Pupils from the highest grade in school B use CD-ROM and CD-I in order to acquire information autonomously. In this school there will be the opportunity for pupils to access the Internet shortly. In school A pupils conduct small research projects in which they use e-mail as well as the telephone. In school A and B CD-ROM may be used for making pieces of work. In all three schools Word processors are used by pupils for writing texts and e-mail messages. Two schools have their own Internet pages. In one of these schools, pupils’ work is being scanned and put on the Internet pages. In all three schools there are e-mail projects. In all three schools there are computers that may be used by pupils after school hours or during breaks. In school C, most of the courseware in use was developed by the ICT co-ordinator, aided by colleagues or parents. There is also some software which was developed by universities, within the framework of special projects. In this school the ‘circuit model’ was developed. The learning content is
subdivided into ‘learning lines’ and projects. Pupils work in these circuits rather autonomously. ICT plays an important role. In all three primary schools, teachers either are obliged to use ICT, or they are strongly stimulated to do so.

In secondary education, the question whether teachers are using ICT or not depends to a large part upon their own decision. ICT is used in informatics, which is taught to the lower grades, and in the office simulation in junior vocational education. In some cases, ICT use is associated with certain subject departments. Because only few teachers have computers in their classrooms, teachers have to book the computer room each time they want to use computers in their classes.

**Effects of using ICT in the school**

According to the principals and the ICT co-ordinators in the primary schools, ICT is an important means for making education more effective. Pupils may work independently with the computer, which provides means to adapt the learning content and the amount of exercise to the capabilities of the pupils. Because teaching time is saved in this manner, there is more opportunity for the teacher to coach pupils who need extra help. Apart from this, pupils enjoy writing texts much more when using computers. Using ICT enhances the pupils’ motivation, which in turn leads to an increase of motivation of some teachers as well. For teachers e-mail provides possibilities to contact colleagues from other schools.

According to the vice-principals in the two secondary schools, ICT provides better opportunities for pupils to work autonomously, and ICT has a positive impact on the pupils’ motivation. Both vice-principals think using ICT in the lessons requires more preparation time, but results in less pressure on the teacher during the lessons.

**Obstacles to using ICT**

Lack of money and lack of time for ICT co-ordination are obstacles that are mentioned in all three primary schools, lack of money being the key problem. The lack of available in-service training is added by one principal. Another problem is lack of space in the school. In all three schools there are plans to increase the number of computers, but there isn’t enough room to install the equipment. Classrooms are too small, and installing the computers in the corridors means pupils have to work outside the classroom. In one of the schools there is a desire for more software which is not linked to a course book, because teachers in this school do not use many course books.
In the secondary schools, lack of money is considered to be a serious obstacle with regard to ICT. Purchasing a sufficient number of computers, maintaining and regularly updating the equipment, and purchasing software, draws heavily on the schools' budgets. The same goes for the time available for the system operator. The division of schools over several locations leads to inefficiency with regard to the installation of computers and networks, as well as with regard to system operation. Apart from this, not all buildings provide enough room for installing computers. One of the vice-principals notes that most of the existing software is not adequate. There is a need for more sophisticated software, which is less directed towards factual knowledge, and which fits better to the curriculum.

5 Spain

Resources and support for ICT

Every school has a substantial number of computers, reaching the ratio of 1:5 computers to students in one case. The centre with Introductory Professional studies has just over 300 computers, other centres with a lower ratio have 25 to 33. These are 486- or Pentium-computers - except in the bigger centre - or equivalent Macintosh. The majority of the computers are in computer rooms while others are in the classrooms, in general one per class in pre-school rooms, and 3 to 5 in primary and secondary classrooms.

The centres that were visited are private schools, and some of them are 'cooperative ones', that is, the parents are the owners of the centre. So in every case the computers are paid by the families but, while in some cases this is by the ordinary budget, in others the parents organize special actions in order to raise money to enable the introduction of Information Technology. By the way, it is necessary to mark that every public centre has received computers from the regional government in Catalonia. Some public centres are supplied with additional machines by other private or public sources, such as the parents associations or the local authorities.

Every centre has organized specific courses for their teachers, except in one case, where teachers were sent to external courses. Some more qualified teachers assure a continuous training process through consultative actions. Because of the private character of these centres, this training was, if not compulsory, at least greatly recommended.

The schools introduce a plan for the use of ICT in the context of the own curriculum through the standard documentation. However, they do not have any plan for
introduction of ICT, e.g. with short and medium objectives for hardware and software acquisition.

Except in the small school, the pedagogical aspects are attended for by the general co-ordinator either in primary or secondary level. Additional technicians are in charge of the co-ordination for the technical and some administrative aspects, such as time and resources management. In the small school the work is not organized in such a hierarchical way and decisions are usually based on horizontal communication and discussion. In this context, the role of the principal usually is to enhance the use of ICT, to facilitate the introduction of ICT and to act as a bridge between teachers and parents.

Teachers' training in ICT does not take place during school hours because of the costs of additional teachers. However, it is usual that courses are taken in September and July, when the teachers have to participate in activities related with the course preparation or training, but when there are no classes.

In relation with the availability of a forum for teachers who are using ICT in the classroom, while in the small school teachers have the opportunity of a high level or interrelation at free times, as during the lunch break, in the bigger ones, teachers can use the space of New Technology Department or equivalent. In public schools some teachers have created some important forums (Callus, 'Claustro virtual', Edulist, etc.) to exchange information about ICT use.

Use of ICT in the school in teaching

Schools and teachers have no restrictions to the use of ICT in the curriculum, other than those imposed by the limited resources and space. Although teachers could take the initiative to use computers, the co-ordinators usually stimulate this use. In some cases it is a teachers' team who stimulated colleagues in this way.

There are no certain categories of students (e.g. gender, age-group, 'academic' ability) targeted for teaching using ICT. From the various answers it is not possible to identify specific subject areas where ICT leads to the largest effect. However, language related areas are more cited, e.g. foreign language, written expression, literacy, etc.

Some schools review at the end of the year whether the proposed objectives have been achieved. But in general the academic results are considered to be indicators of the general efficiency of computers in specific subjects.
Effects of using ICT in the school

Some aspects have been marked about how the use of ICT affects teacher-pupil relations. While the dependence is higher during the first days, the students develop a high independence for work during the rest of the course. Motivation is an element frequently cited and usually there is a positive attitude of students with regard to teachers that use computers.

In general, ICT has been integrated in other classroom activities, but the need of accessing a special room affects this integration, except in one centre where computers have been introduced in the classroom. In pre-school classrooms the situation is different because computers are situated in the classroom.

The main benefits of using ICT, according to the principals’ answers, are the improved organization of materials, the extended information storing capacity, the high level of student motivation and the integration with real life.

These schools reflect the low level of integration of Internet in private centres, as opposite to public centres in Catalonia, where every teacher at primary and secondary level has the opportunity of asking for an e-mail account or for a Web site for his/her materials. Public teachers usually participate in telematics forums as lists (Edulist, Edutec...), at videoconference virtual systems (‘Claustre virtual’) or in annual conventions (‘Callús’) as well as in international projects (connecting with US astronaut, the Moebius project and other projects in the Socrates programme). However, no one of these private schools has developed projects through Internet or other telematics resources.

Obstacles to using ICT

The main barriers to increased use of ICT in the schools are, generally, the limited resources, related with the fast changes in ICT. Some principals note the high prices of software and others note the limited availability of educational software. Some initial negative feelings of some teachers about ICT have quickly disappeared. The main barrier is, always, the economic one. The problem related with some negative initial attitudes of some teachers has been solved by specific training. But the economic problem seems to have only one solution: to take strong actions.
6 Summary

Support and resources

- In primary education, a limited number of computers are often situated inside the classrooms, these schools usually not being equipped with a computer room (the Irish schools are an exception here).
- In secondary schools there usually are computer rooms, whereas not many teachers have a computer inside their own classroom.

Use of ICT in the school

- The use of ICT in most cases depends upon the personal initiative of teachers.
- It seems that in primary schools the computers often are better integrated in the lessons, whereas in secondary education the use of ICT is often restricted to certain classes and to certain subjects, mainly informatics.

Effects of using ICT

- ICT provides more opportunities for individualization;
- ICT provides more opportunities for cooperative learning;
- the pupils’ motivation is increased;
- the pupil-pupil and pupil-teacher communication is enhanced;
- pupils learn how to handle computers;
- education is better integrated with ‘real life’;
- the teacher acts more as a coach;
- teaching time is saved;
- E-mail provides better opportunities for communication;
- the Internet is a huge source of information.
Main obstacles for the implementation of ICT

- lack of money;
- insufficient attention for ICT in pre-service teacher training;
- absent or inadequate in-service teacher training.
Annex 4 - The case studies: results from the teachers’ survey

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3 Resources for ICT use 146
4 Characterization of the ICT learning environment 147
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7 Impact of ICT on the pupils 155
8 Impact of ICT on the teacher 156
9 Barriers to (the increase of) ICT use in education 159

1 Background information

Table 1 provides an overview of the number of teachers in primary and secondary education respectively who filled out the questionnaire.

Table 1 - Number of teachers per country in primary and secondary schools respectively

<table>
<thead>
<tr>
<th></th>
<th>BEL</th>
<th>GER</th>
<th>IRL</th>
<th>NL</th>
<th>SP</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>primary education</td>
<td>23</td>
<td>17</td>
<td>64</td>
<td>12</td>
<td>5</td>
<td>121</td>
</tr>
<tr>
<td>secondary education</td>
<td>133</td>
<td>48</td>
<td>9</td>
<td>37</td>
<td>-</td>
<td>227</td>
</tr>
<tr>
<td>primary + secondary education</td>
<td>55</td>
<td>55</td>
<td>55</td>
<td>49</td>
<td>60</td>
<td>403</td>
</tr>
</tbody>
</table>

In Spain, the majority (55) of the teachers were employed by schools providing primary as well as secondary education. From this group, 25 filled out the questions with reference to pupil groups in primary education, whereas 26 chose secondary education...
groups. Four teachers referred to primary as well as secondary education when answering the questions.

Two third of the teachers were females, the average number of years of experience in education being 18. The majority of these teachers (84 percent) indicate they have experience with computers (although not necessarily with computer use in education). The average number of years the computer experienced teachers have been using computers, varies from 6 (Spain) to 8 (The Netherlands). Many teachers claim they are inexperienced (29 percent) or quite inexperienced (31 percent) with regard to ICT use. Four out of ten teachers claim they are quite experienced (31 percent) or experienced (9 percent) in using ICT.

Not many teachers, only 22 percent, have access to a computer at home. A majority have Internet access (74 percent) and/or access to e-mail (69 percent), but again just a small group has access at home (see table 2).

<table>
<thead>
<tr>
<th>Access to Computer</th>
<th>Percentage</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>At Home</td>
<td>22%</td>
<td>90</td>
</tr>
<tr>
<td>Internet at School</td>
<td>56%</td>
<td>221</td>
</tr>
<tr>
<td>Internet at Home</td>
<td>5%</td>
<td>21</td>
</tr>
<tr>
<td>Internet at Home and School</td>
<td>13%</td>
<td>51</td>
</tr>
<tr>
<td>No Internet Access</td>
<td>26%</td>
<td>104</td>
</tr>
<tr>
<td>E-mail at School</td>
<td>53%</td>
<td>210</td>
</tr>
<tr>
<td>E-mail at Home</td>
<td>6%</td>
<td>21</td>
</tr>
<tr>
<td>E-mail at Home and School</td>
<td>11%</td>
<td>43</td>
</tr>
<tr>
<td>No E-mail</td>
<td>31%</td>
<td>121</td>
</tr>
</tbody>
</table>

1 As far as a distinction is being made in the analyses between primary and secondary education, the group of 25 is attributed to primary education, the group of 26 is attributed to secondary education, and the group of 4 is left out of the analyses.
2 ICT use in education

At this point we have to stress the case studies provide a view of the situation in technology rich schools, which may be considered to show above average use of ICT. This means the survey does not provide a representative overview of the use of ICT in education.

Table 3 shows that just over 50 percent of the teachers who processed the questionnaire do not use computers during their lessons. The table also shows a remarkable difference between primary and secondary schools with regard to ICT use. In the primary schools that were selected for the case studies, 69 percent of the teachers use ICT in their classes, whereas in the secondary schools this only applies to 34 percent of the teachers. In the primary schools in the case study sample, 31 percent of the teachers (quite) often use computers during their lessons; in secondary schools just 10 percent use computers (quite) often. There are striking differences between countries, but these may to a large part be attributed to the types of schools selected. In the Belgian and Dutch primary schools in the sample substantially more teachers use ICT than in the secondary schools. In the Irish case studies this is also the case, but the difference is smaller. In the German and Spanish case schools there are hardly any differences between primary and secondary level teachers with regard to ICT use in the classroom.

Table 3 - Use of computers during the lessons: 403 teachers

<table>
<thead>
<tr>
<th></th>
<th>primary schools</th>
<th>secondary schools</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>no</td>
<td>45</td>
<td>31%</td>
<td>166</td>
</tr>
<tr>
<td>sometimes</td>
<td>56</td>
<td>38%</td>
<td>60</td>
</tr>
<tr>
<td>quite often</td>
<td>29</td>
<td>20%</td>
<td>11</td>
</tr>
<tr>
<td>very often</td>
<td>16</td>
<td>11%</td>
<td>16</td>
</tr>
</tbody>
</table>

The reason for not using ICT which is mentioned most frequently is the fact that teachers are not familiar with ICT or feel unsure about it (see table 4). This applies to 29 percent of the teachers who answered the question why they do not use ICT in their classes. This reason is much more important than insufficient access to hardware, which is mentioned by 19 percent, or lack of suitable software (16 percent).
Table 4 - Reasons for not using ICT during the lessons (number and percentage of 161 teachers who mentioned reasons for not using ICT in education)

<table>
<thead>
<tr>
<th>Reason</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>- not familiar with ICT / unsure about ICT</td>
<td>47</td>
<td>29%</td>
</tr>
<tr>
<td>- not enough hardware / no computers in my classroom</td>
<td>31</td>
<td>19%</td>
</tr>
<tr>
<td>- lack of suitable software / I don’t know suitable software</td>
<td>26</td>
<td>16%</td>
</tr>
<tr>
<td>- the curriculum leaves no space for ICT use</td>
<td>20</td>
<td>12%</td>
</tr>
<tr>
<td>- ‘I don’t see the necessity’</td>
<td>19</td>
<td>12%</td>
</tr>
<tr>
<td>- the type of subject (e.g. physical training, Greek, history)</td>
<td>14</td>
<td>9%</td>
</tr>
<tr>
<td>- lack of time to familiarize with the possibilities of ICT</td>
<td>11</td>
<td>7%</td>
</tr>
</tbody>
</table>

Note: The following sections refer to 191 teachers who are using ICT in their classrooms.

3 Resources for ICT use

The majority of ICT using teachers, 83 percent, teach at a school that is equipped with a computer room. The number of computers in that room varies from 7 to 30. The average is 14 computers. From this teacher group, 11 percent does not use the computer room, but uses computers in their own classroom instead. Two out of three teachers who have access to a computer room at school always use this room when they decide to use ICT in their classes, whereas 22 percent sometimes uses the computer room and sometimes uses computers in their own classroom.

On the whole, 17 percent of the ICT using teachers always stay in their own classroom while their pupils are working with ICT, and 63 percent always go to the computer room. The majority (55 percent) does not have a computer in their classroom. If teachers have computers in their classroom, in general it is just one computer (34 percent). Some teachers have 2 computers (4 percent) in their classroom. Nearly 25 percent of the teachers state their pupils may access computers elsewhere (outside of the classroom) during their lessons. These are mainly computers in school corridors (mentioned 11 times), in the teachers’ room (9 times), and in the media centre or library (8 times).

Just over half of the teachers state their pupils may also use CD-ROM. Pupils can hardly access any other ‘new’ technology except computers. CD-i or interactive videodisc are quite rare in the schools in which the survey was undertaken (2 percent of the teachers may access these technologies). About half of the teacher group (52 percent) states their pupils have access to e-mail and/or the Internet (45 percent may access both). Forty
percent neither has access to e-mail nor to the Internet. At this point, there are some interesting differences between countries. In the Dutch and the Spanish schools, more than 75 percent of the teachers state that pupils can access neither e-mail nor the Internet. In the German and Irish schools this goes with about 20 percent, whereas in the Belgian sample just 10 percent have no access to e-mail or the Internet. Of course these differences might be caused by the selection of schools. Nevertheless, this gives an impression of differences in the potential use of ICT within the schools in which the case studies were undertaken. There were no significant differences between primary and secondary schools with regard to this aspect.

4 Characterization of the ICT learning environment

Several questions in the questionnaire address the way the learning environment is modelled in which ICT is being used. Tables 5 and 6 provide an overview of the purposes ICT is used for and the types of ICT applications used.

Table 5 - Purposes ICT is used for in the lessons; 181 teachers (97 primary and 84 secondary teachers)

<table>
<thead>
<tr>
<th></th>
<th>never</th>
<th>sometimes</th>
<th>quite often</th>
<th>often</th>
</tr>
</thead>
<tbody>
<tr>
<td>primary education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- for exercises</td>
<td>18%</td>
<td>31%</td>
<td>26%</td>
<td>26%</td>
</tr>
<tr>
<td>- for writing letters / texts</td>
<td>35%</td>
<td>22%</td>
<td>23%</td>
<td>21%</td>
</tr>
<tr>
<td>- for remediation (of slow learners)</td>
<td>28%</td>
<td>35%</td>
<td>19%</td>
<td>19%</td>
</tr>
<tr>
<td>- for problem solving</td>
<td>36%</td>
<td>26%</td>
<td>27%</td>
<td>11%</td>
</tr>
<tr>
<td>- for enrichment (of fast learners)</td>
<td>35%</td>
<td>30%</td>
<td>23%</td>
<td>12%</td>
</tr>
<tr>
<td>- for communication</td>
<td>58%</td>
<td>23%</td>
<td>10%</td>
<td>9%</td>
</tr>
<tr>
<td>- for collecting information</td>
<td>51%</td>
<td>35%</td>
<td>10%</td>
<td>4%</td>
</tr>
<tr>
<td>- for explaining learning content</td>
<td>58%</td>
<td>30%</td>
<td>10%</td>
<td>2%</td>
</tr>
<tr>
<td>- for data-processing</td>
<td>80%</td>
<td>16%</td>
<td>3%</td>
<td>1%</td>
</tr>
<tr>
<td>secondary education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- for exercises</td>
<td>19%</td>
<td>50%</td>
<td>16%</td>
<td>16%</td>
</tr>
<tr>
<td>- for enrichment (of fast learners)</td>
<td>39%</td>
<td>41%</td>
<td>16%</td>
<td>5%</td>
</tr>
<tr>
<td>- for writing letters / texts</td>
<td>61%</td>
<td>13%</td>
<td>12%</td>
<td>14%</td>
</tr>
<tr>
<td>- for explaining learning content</td>
<td>48%</td>
<td>42%</td>
<td>4%</td>
<td>7%</td>
</tr>
<tr>
<td>- for problem solving</td>
<td>46%</td>
<td>44%</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>- for collecting information</td>
<td>63%</td>
<td>21%</td>
<td>7%</td>
<td>8%</td>
</tr>
<tr>
<td>- for remediation (of slow learners)</td>
<td>58%</td>
<td>27%</td>
<td>12%</td>
<td>2%</td>
</tr>
<tr>
<td>- for data-processing</td>
<td>64%</td>
<td>24%</td>
<td>4%</td>
<td>8%</td>
</tr>
<tr>
<td>- for communication</td>
<td>76%</td>
<td>13%</td>
<td>6%</td>
<td>5%</td>
</tr>
</tbody>
</table>
ICT is often being used for exercises: half of the group of primary teachers who use ICT in their classes, quite often or often use ICT for exercises. Another purpose ICT is used for quite often in primary schools, is for writing letters or texts by pupils. For this purpose computers are used (quite) often according to 45 percent of the ICT using primary teachers. Over one third use ICT (quite) often for remediation of slow learners. The same goes for the use of ICT for enrichment of fast learners, and for problem solving. Other purposes that ICT might be used for, e.g. for explaining learning content, for collecting information, for communication, or for data-processing, seem to be not very popular among primary school teachers.

Overall, in secondary education ICT proves to be put into action considerably less often than in primary education. The most popular type of ICT use, as in primary education, is for exercises: one third of the group of secondary teachers who use ICT in their classes, quite often or often use ICT for exercises. A (quite) frequent use of ICT for pupils writing letters or texts applies to one out of four ICT using teachers in secondary schools. ICT is used (quite) often for enrichment of fast learners by one out of five ICT using teachers. Other purposes ICT is used for rather frequently, were put forward by less than 20 percent of the ICT using teachers in the secondary schools.

Table 6 shows that drill and practice is the type of ICT application which is being used most frequently by the primary school teachers participating in our survey. Half of the group of teachers who use ICT in their classes (quite) often use drill and practice applications. Games and adventures (used quite often or often by 44 percent) are rather popular as well, just like word processing and problem solving applications (used on a regular basis by one third of the teachers).

In secondary schools, drill and practice exercises and word processing are being used (quite) frequently by a quarter of the ICT using teachers. Spreadsheets are used (quite) often by one out of five. Other ICT application types are not very popular among these teachers: problem solving applications were applied only by half of the teacher group who stated they use ICT in their classes, and they were not used often. Simulations, databases, tutorials, the Internet, e-mail, games or adventures, and programming are used by a minority of teachers, and this minority generally uses these applications not often. The use of video conferencing was mentioned by just one teacher.
### Table 6 - Type of ICT applications pupils use during the lessons: 175 teachers (96 primary and 79 secondary teachers)

<table>
<thead>
<tr>
<th></th>
<th>never</th>
<th>sometimes</th>
<th>quite often</th>
<th>often</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>primary education</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- drill and practice</td>
<td>21%</td>
<td>28%</td>
<td>27%</td>
<td>24%</td>
</tr>
<tr>
<td>- games / adventures</td>
<td>23%</td>
<td>33%</td>
<td>24%</td>
<td>20%</td>
</tr>
<tr>
<td>- word processing</td>
<td>38%</td>
<td>31%</td>
<td>17%</td>
<td>15%</td>
</tr>
<tr>
<td>- problem solving applications</td>
<td>43%</td>
<td>22%</td>
<td>23%</td>
<td>13%</td>
</tr>
<tr>
<td>- tutorials</td>
<td>72%</td>
<td>16%</td>
<td>7%</td>
<td>5%</td>
</tr>
<tr>
<td>- simulations</td>
<td>74%</td>
<td>13%</td>
<td>9%</td>
<td>4%</td>
</tr>
<tr>
<td>- electronic mail (e-mail)</td>
<td>70%</td>
<td>21%</td>
<td>7%</td>
<td>2%</td>
</tr>
<tr>
<td>- Internet / World Wide Web</td>
<td>70%</td>
<td>22%</td>
<td>6%</td>
<td>2%</td>
</tr>
<tr>
<td>- databases</td>
<td>81%</td>
<td>16%</td>
<td>3%</td>
<td>---</td>
</tr>
<tr>
<td>- spreadsheets</td>
<td>92%</td>
<td>4%</td>
<td>3%</td>
<td>1%</td>
</tr>
<tr>
<td>- programming</td>
<td>94%</td>
<td>5%</td>
<td>1%</td>
<td>---</td>
</tr>
<tr>
<td>- video conferencing</td>
<td>100%</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>secondary education</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- drill and practice</td>
<td>39%</td>
<td>38%</td>
<td>13%</td>
<td>10%</td>
</tr>
<tr>
<td>- word processing</td>
<td>51%</td>
<td>24%</td>
<td>10%</td>
<td>15%</td>
</tr>
<tr>
<td>- spreadsheets</td>
<td>63%</td>
<td>18%</td>
<td>9%</td>
<td>10%</td>
</tr>
<tr>
<td>- problem solving applications</td>
<td>52%</td>
<td>44%</td>
<td>3%</td>
<td>1%</td>
</tr>
<tr>
<td>- simulations</td>
<td>63%</td>
<td>27%</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>- databases</td>
<td>73%</td>
<td>15%</td>
<td>4%</td>
<td>8%</td>
</tr>
<tr>
<td>- tutorials</td>
<td>65%</td>
<td>29%</td>
<td>4%</td>
<td>3%</td>
</tr>
<tr>
<td>- Internet / World Wide Web</td>
<td>76%</td>
<td>15%</td>
<td>6%</td>
<td>3%</td>
</tr>
<tr>
<td>- games / adventures</td>
<td>76%</td>
<td>22%</td>
<td>3%</td>
<td>---</td>
</tr>
<tr>
<td>- electronic mail (e-mail)</td>
<td>82%</td>
<td>11%</td>
<td>6%</td>
<td>---</td>
</tr>
<tr>
<td>- programming</td>
<td>87%</td>
<td>9%</td>
<td>1%</td>
<td>3%</td>
</tr>
<tr>
<td>- video conferencing</td>
<td>99%</td>
<td>1%</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

A comparison between primary and secondary education shows that ICT use in secondary education lags behind. A striking difference concerns the use of problem solving applications, which is almost absent in secondary education.
As far as grouping of pupils working with ICT is concerned, working in pairs is the approach which is noted most frequently, as table 7 shows. This goes for primary as well as secondary education. In primary schools, working individually and working in small groups are quite popular also, although they are not noted as frequently as working in pairs. In secondary schools, working individually comes in second, whereas working in small groups is applied only by a minority of teachers. Whole class teaching during ICT work is applied by a minority of teachers in primary as well as secondary education.

According to 50 percent of the teachers, in general the whole class is working with computers simultaneously when ICT is being used during their lessons. Just over one third (50 percent of the primary school teachers and 20 percent of the secondary school teachers) state the class is never working simultaneously with ICT. This of course is connected with the number of computers available, which consequently also affects the possibilities of pupil grouping.

Table 8 provides an overview of the way teachers assist pupils when they are going to use ICT or during ICT use.
Table 8 - Ways of assisting pupils when they are using ICT: 176 teachers

<table>
<thead>
<tr>
<th>Activity</th>
<th>Never</th>
<th>Sometimes</th>
<th>Quite Often</th>
<th>Often</th>
</tr>
</thead>
<tbody>
<tr>
<td>I regularly check how they are doing</td>
<td>7%</td>
<td>12%</td>
<td>30%</td>
<td>51%</td>
</tr>
<tr>
<td>I tell the pupils exactly what to do before they start working with computers</td>
<td>8%</td>
<td>31%</td>
<td>22%</td>
<td>39%</td>
</tr>
<tr>
<td>When pupils ask a question, I give them a clue, in order to help them find the answer</td>
<td>11%</td>
<td>26%</td>
<td>28%</td>
<td>35%</td>
</tr>
<tr>
<td>When pupils ask a question, I answer it directly</td>
<td>10%</td>
<td>42%</td>
<td>20%</td>
<td>29%</td>
</tr>
<tr>
<td>I give some pupils using computers more attention than other pupils using computers</td>
<td>24%</td>
<td>33%</td>
<td>24%</td>
<td>19%</td>
</tr>
<tr>
<td>I work with pupils who are not using computers at that moment</td>
<td>63%</td>
<td>13%</td>
<td>8%</td>
<td>17%</td>
</tr>
</tbody>
</table>

A majority of teachers tell their pupils exactly what they have to do before they start working with computers, and regularly check on them during computer work. The most notable difference between primary and secondary teachers with respect to assisting pupils is that in primary schools teachers are more often working with pupils who are not using ICT at that moment: one out of three primary school teachers chooses to do this (quite) often, as opposed to one out of ten secondary school teachers. As for the grouping of pupils, this may be expected to be affected by the number of computers available, which in general is larger in secondary classes when ICT is being used. Apart from the ways of assisting pupils mentioned in the table, several teachers point out that pupils may be assisted by other pupils.

Table 9 gives an overview of the way the activities undertaken with ICT are being evaluated. Often teachers discuss the results of the tasks the pupils conducted individually or with the whole class. Apart from this, in primary schools pupils are quite often invited to discuss with other pupils what they did. In secondary schools this approach is applied considerably less often.
Table 9 - Ways of evaluating the activities the pupils undertake with ICT; 172 teachers

<table>
<thead>
<tr>
<th>Activity</th>
<th>never</th>
<th>sometimes</th>
<th>quite often</th>
<th>often</th>
</tr>
</thead>
<tbody>
<tr>
<td>primary education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- I discuss what pupils did individually</td>
<td>15%</td>
<td>50%</td>
<td>26%</td>
<td>10%</td>
</tr>
<tr>
<td>- pupils discuss what they did with other pupils</td>
<td>29%</td>
<td>30%</td>
<td>34%</td>
<td>7%</td>
</tr>
<tr>
<td>- I discuss what pupils did with the whole class</td>
<td>32%</td>
<td>34%</td>
<td>27%</td>
<td>7%</td>
</tr>
<tr>
<td>- I discuss what pupils did in small groups</td>
<td>38%</td>
<td>28%</td>
<td>28%</td>
<td>6%</td>
</tr>
<tr>
<td>- I check a computer log file</td>
<td>64%</td>
<td>22%</td>
<td>10%</td>
<td>4%</td>
</tr>
<tr>
<td>secondary education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- I discuss what pupils did individually</td>
<td>25%</td>
<td>40%</td>
<td>16%</td>
<td>19%</td>
</tr>
<tr>
<td>- I discuss what pupils did with the whole class</td>
<td>40%</td>
<td>29%</td>
<td>17%</td>
<td>13%</td>
</tr>
<tr>
<td>- I discuss what pupils did in small groups</td>
<td>48%</td>
<td>27%</td>
<td>16%</td>
<td>9%</td>
</tr>
<tr>
<td>- pupils discuss what they did with other pupils</td>
<td>45%</td>
<td>32%</td>
<td>20%</td>
<td>3%</td>
</tr>
<tr>
<td>- I check a computer log file</td>
<td>64%</td>
<td>15%</td>
<td>12%</td>
<td>9%</td>
</tr>
</tbody>
</table>

5 Professional development and support

Table 10 provides an overview of the support teachers get with regard to the use of ICT at school.

Table 10 - Support with regard to ICT use

<table>
<thead>
<tr>
<th>Source</th>
<th>no support</th>
<th>little support</th>
<th>some support</th>
<th>a lot of support</th>
<th>n.a.</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>- from the ICT co-ordinator</td>
<td>6%</td>
<td>4%</td>
<td>12%</td>
<td>59%</td>
<td>20%</td>
<td>173</td>
</tr>
<tr>
<td>- from the school principal</td>
<td>13%</td>
<td>5%</td>
<td>21%</td>
<td>52%</td>
<td>9%</td>
<td>177</td>
</tr>
<tr>
<td>- from the system operator</td>
<td>8%</td>
<td>4%</td>
<td>10%</td>
<td>24%</td>
<td>53%</td>
<td>170</td>
</tr>
<tr>
<td>- from an external helpdesk</td>
<td>23%</td>
<td>9%</td>
<td>6%</td>
<td>3%</td>
<td>59%</td>
<td>171</td>
</tr>
<tr>
<td>- from an educational support institution</td>
<td>23%</td>
<td>8%</td>
<td>11%</td>
<td>3%</td>
<td>55%</td>
<td>171</td>
</tr>
</tbody>
</table>

Teachers generally claim to get quite some support from the ICT co-ordinator (if there is such a co-ordinator) and from the school principal. If there is a system operator, this
person usually gives sufficient support as well. However, 50 percent of the teachers claim there is no system operator at their school. Hardly any teachers get support with regard to ICT use from an external helpdesk or from an educational support institution. Apart from the support listed in the table, several teachers mention they get support from colleagues with regard to ICT use.

As far as communication about ICT use is concerned, colleagues from the same school are consulted most frequently, as table 11 shows. The ICT co-ordinator is also an important source of information. Half of the ICT using teacher group (quite) often communicates with colleagues from their school and/or with the ICT co-ordinator about using ICT. Communication with the school principal takes place less frequently, although still one third (quite) often talks to the school principal about ICT. There is not much communication about ICT with colleagues from other schools, nor with parents.

**Table 11 - Communication about ICT use**

<table>
<thead>
<tr>
<th></th>
<th>never</th>
<th>sometimes</th>
<th>quite often</th>
<th>often</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>with colleagues in school</td>
<td>2%</td>
<td>43%</td>
<td>38%</td>
<td>16%</td>
<td>176</td>
</tr>
<tr>
<td>with the ICT co-ordinator</td>
<td>20%</td>
<td>28%</td>
<td>26%</td>
<td>26%</td>
<td>167</td>
</tr>
<tr>
<td>with the school principal</td>
<td>26%</td>
<td>43%</td>
<td>15%</td>
<td>16%</td>
<td>173</td>
</tr>
<tr>
<td>with colleagues from other schools</td>
<td>35%</td>
<td>54%</td>
<td>9%</td>
<td>2%</td>
<td>173</td>
</tr>
<tr>
<td>with parents</td>
<td>51%</td>
<td>46%</td>
<td>2%</td>
<td>1%</td>
<td>167</td>
</tr>
</tbody>
</table>

Using ICT themselves and communicating with colleagues are, according to the teachers, the means that best helped them acquire skills with regard to ICT use (see table 12). In-service teacher training provided a lot of help for one out of five teachers only. The impact of pre-service teacher training and other ICT training is negligible.
The Impact of Information and Communication Technology on the Teacher

Table 12 - Activities helping to acquire skills with regard to ICT use (in general as well as in education)

<table>
<thead>
<tr>
<th>Activity</th>
<th>no help</th>
<th>little help</th>
<th>some help</th>
<th>a lot of help</th>
<th>n.a.</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>- using ICT myself</td>
<td>2%</td>
<td>9%</td>
<td>22%</td>
<td>61%</td>
<td>6%</td>
<td>180</td>
</tr>
<tr>
<td>- communication with colleagues</td>
<td>3%</td>
<td>18%</td>
<td>30%</td>
<td>45%</td>
<td>5%</td>
<td>182</td>
</tr>
<tr>
<td>- in-service teacher training</td>
<td>17%</td>
<td>12%</td>
<td>29%</td>
<td>21%</td>
<td>22%</td>
<td>178</td>
</tr>
<tr>
<td>- other ICT training</td>
<td>10%</td>
<td>2%</td>
<td>14%</td>
<td>19%</td>
<td>56%</td>
<td>160</td>
</tr>
<tr>
<td>- pre-service teacher training</td>
<td>33%</td>
<td>9%</td>
<td>11%</td>
<td>9%</td>
<td>38%</td>
<td>178</td>
</tr>
</tbody>
</table>

6 ICT use outside of the classroom

Apart from using ICT in the lessons, teachers may also use ICT for various activities outside the classroom, which are connected to their activities as a teacher, e.g. preparing lesson plans, looking for teaching materials, and keeping track of pupils’ achievements (see table 13).

Table 13 - ICT use outside of the classroom

<table>
<thead>
<tr>
<th>Activity</th>
<th>never</th>
<th>sometimes</th>
<th>quite often</th>
<th>often</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>- making lesson plans</td>
<td>36%</td>
<td>26%</td>
<td>13%</td>
<td>25%</td>
<td>172</td>
</tr>
<tr>
<td>- keeping track of pupils’ achievements</td>
<td>45%</td>
<td>19%</td>
<td>15%</td>
<td>20%</td>
<td>157</td>
</tr>
<tr>
<td>- looking for teaching materials</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>on CD-ROM</td>
<td>40%</td>
<td>35%</td>
<td>17%</td>
<td>9%</td>
<td>167</td>
</tr>
<tr>
<td>- looking for teaching materials</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>on the Internet</td>
<td>57%</td>
<td>26%</td>
<td>10%</td>
<td>8%</td>
<td>161</td>
</tr>
<tr>
<td>- contacting colleagues by e-mail</td>
<td>58%</td>
<td>27%</td>
<td>6%</td>
<td>9%</td>
<td>154</td>
</tr>
</tbody>
</table>

Nearly 40 percent of the teachers who are using ICT in their classes make use of computers for making lesson plans on a regular basis. One out of three regularly uses computers for keeping track of pupils’ achievements. Just a small group regularly looks for teaching materials on CD-ROM or on the Internet. The same goes for teachers’
contacts with colleagues. One out of five teachers mentions other activities they undertake outside the classroom with ICT. Amongst other things, they mention word processing (11 times), preparing tests (7 times), administration (6 times), and preparing teaching materials (5 times).

7 Impact of ICT on the pupils

As stated before, teachers’ beliefs about the impact of ICT use on the pupils are an important factor that is influencing their decision whether or not to use ICT in the classroom. Table 14 lists the teachers’ views with regard to this topic.

Table 14 - Impact of ICT on the pupils, according to the ICT using teachers

<table>
<thead>
<tr>
<th></th>
<th>worse with ICT</th>
<th>about equal</th>
<th>better with ICT</th>
<th>don’t know</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>- motivation</td>
<td>----</td>
<td>12%</td>
<td>83%</td>
<td>6%</td>
<td>180</td>
</tr>
<tr>
<td>- interest in the subject</td>
<td>----</td>
<td>20%</td>
<td>73%</td>
<td>7%</td>
<td>180</td>
</tr>
<tr>
<td>- information handling skills</td>
<td>1%</td>
<td>16%</td>
<td>68%</td>
<td>15%</td>
<td>173</td>
</tr>
<tr>
<td>- concentration / involvement</td>
<td>2%</td>
<td>21%</td>
<td>68%</td>
<td>10%</td>
<td>179</td>
</tr>
<tr>
<td>- learning achievements</td>
<td>1%</td>
<td>31%</td>
<td>58%</td>
<td>11%</td>
<td>178</td>
</tr>
<tr>
<td>- learning efficiency</td>
<td>1%</td>
<td>27%</td>
<td>54%</td>
<td>18%</td>
<td>177</td>
</tr>
<tr>
<td>- problem solving skills</td>
<td>1%</td>
<td>28%</td>
<td>52%</td>
<td>19%</td>
<td>175</td>
</tr>
<tr>
<td>- transfer / application of knowledge</td>
<td>2%</td>
<td>30%</td>
<td>47%</td>
<td>21%</td>
<td>175</td>
</tr>
<tr>
<td>- creativity</td>
<td>12%</td>
<td>36%</td>
<td>32%</td>
<td>20%</td>
<td>177</td>
</tr>
<tr>
<td>- social skills</td>
<td>10%</td>
<td>39%</td>
<td>30%</td>
<td>21%</td>
<td>176</td>
</tr>
</tbody>
</table>

The ICT using teachers who took part in the survey in general have very favourable ideas regarding the influence of ICT use in the education process on the pupils: a large majority think the pupils’ motivation is better when using ICT, pupils show more interest in the subject, and ICT has a positive impact on the pupils’ information handling skills, as well as on their amount of concentration and involvement in the task. Over 50 percent think ICT leads to better learning achievements, better learning efficiency, and an improvement of problem solving skills, as compared to education without ICT use. Nearly 50 percent think the pupils’ ability to apply the knowledge gained is enhanced when ICT is used. With regard to all these aspects, hardly any ICT using teacher has the
impression ICT has a negative influence as compared to education without the use of ICT.

There are two aspects about which the teachers are less confident, as far as ICT use is concerned: creativity and social skills. But then, still the group who believes these aspects are negatively influenced by using ICT when compared to a traditional educational approach (about one out of ten teachers), is being outnumbered by their colleagues (about one out of three) who feel ICT has a positive impact on these aspects.

8 Impact of ICT on the teacher

The ICT using teachers in the teachers’ survey in general are quite enthusiastic about the impact of ICT on the teacher, as table 15 shows. The majority (two out of three teachers) feel ICT use has a positive impact on their professional development. Fifty percent of the ICT using teachers believe ICT has a positive impact on the efficiency of their work. The same goes for the impact on the teacher’s motivation. With regard to these three aspects hardly anyone feels the use of ICT has a negative impact, as compared to teaching without the use of ICT.

<table>
<thead>
<tr>
<th>Table 15 - Impact of ICT on the teacher, according to the ICT using teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>worse with ICT</td>
</tr>
<tr>
<td>- the teacher’s professional development 1%</td>
</tr>
<tr>
<td>- efficiency of the teacher’s work 2%</td>
</tr>
<tr>
<td>- the teacher’s motivation 3%</td>
</tr>
<tr>
<td>- preparation of lessons 3%</td>
</tr>
<tr>
<td>- interaction with pupils 9%</td>
</tr>
<tr>
<td>- keeping track of pupils’ achievements 7%</td>
</tr>
<tr>
<td>- social contact with pupils 8%</td>
</tr>
<tr>
<td>- the teacher’s workload 18%</td>
</tr>
</tbody>
</table>

With regard to the preparation of lessons, interaction with pupils, keeping track of pupils’ achievements, social contact with pupils, and the teacher’s workload, a substantial group feels there are no main differences compared to teaching without ICT.
The group of teachers who judge these aspects to be worse with ICT, however, is a lot smaller than the group who notes an improvement when using ICT. The aspect which seems to have the less positive impact, is the influence on the teacher’s workload, one out of five ICT using teachers having the impression there is a negative impact at this point. On the other hand, one out of three states ICT has a positive impact on their workload.

With regard to two aspects there are significant differences between primary and secondary education teachers’ views (after leaving out the ‘I don’t know’ category). Teachers in secondary schools generally have more favourable views with regard to the impact of ICT on the efficiency of their work: six out of ten feel they work more efficiently with ICT, whereas four out of ten primary school teachers share this view. Four out of ten teachers in secondary schools in general think ICT enables them to keep track of pupils’ achievements better than would be the case without ICT. Of the teachers in primary schools one out of five feels this way.

Table 16 gives an overview of the answers to the (open-ended) question with regard to the main benefits of ICT for the teacher (see also text frame).

<table>
<thead>
<tr>
<th>Table 16 - Main benefits of ICT for the teacher (numbers and percentages of 124 teachers who answered this question)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>number</td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>time benefit / increase in efficiency</td>
</tr>
<tr>
<td>pupils are more motivated and stimulated</td>
</tr>
<tr>
<td>more variety / diversity in teaching methods</td>
</tr>
<tr>
<td>ICT facilitates writing and reusing of texts, tests, and lesson plans</td>
</tr>
<tr>
<td>ICT provides easy access to a lot of information</td>
</tr>
<tr>
<td>ICT facilitates differentiation</td>
</tr>
<tr>
<td>texts and notes look better when they are produced with ICT</td>
</tr>
</tbody>
</table>

This question yielded several answers with regard to the time benefit or increase of efficiency which results from using ICT. Some teachers added that this time benefit leads to the availability of extra time for the teacher to assist pupils who need extra attention. Another important benefit is the fact that teachers feel pupils are more motivated and stimulated when using ICT.
Benefits of ICT use: some statements from teachers

'Too much to tell; my job became much easier and more interesting'
'Motivated students make motivated teachers'
'It gives me a great thrill to see how capable the children are on the computer'
'I enjoy using computers; it's a new interest for me; I find I'm always motivated to look for new material'
'Initially more of a workload. You must know what you are doing, but long-term more relaxing and enjoyable'
'Variety, change from traditional class methods'
'No discipline problems; great feedback from pupils'
'The teacher's role is more attractive: towards coaching and stimulating'
'Education changes fast, which is exciting'

Another important benefit is the increasing diversity in teaching methods which comes with ICT use. Several teachers also feel that ICT facilitates the writing and reusing of texts, tests, and lesson plans, as well as the fact that these texts get a more professional look when they are produced with the computer's help. Easy access to a lot of information (in databases or via the Internet) is also mentioned often. Finally, several teachers point at the opportunities ICT holds for adapting to the pupils' individual needs (see also text frame).

Table 17 gives an overview of the teachers' ideas with regard to some statements we formulated concerning the impact of ICT on the teacher's task. The reactions to the statements are in general quite favourable towards ICT. A large majority of the teachers feel using ICT resulted in a shift in the teacher's role, from a lecturer to a coach. A large majority also feel that thanks to using ICT they can spend more time assisting pupils who need extra attention, they can do their work more efficiently, and they like being a teacher better. A majority think there is not more pressure on them during the lessons when using ICT, and a majority also feel it is not more difficult to keep track of the pupils' achievements when pupils are working with ICT. There is some disagreement with regard to the question whether using ICT leads to the teacher having to deal with more problems during the lessons, and the question whether using ICT enhances the teacher-pupil contact.
Table 17 - Statements with regard to the impact of ICT on the teacher’s task

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Agree</th>
<th>Strongly agree</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have become more a coach instead of a lecturer</td>
<td>4%</td>
<td>12%</td>
<td>66%</td>
<td>18%</td>
<td>169</td>
</tr>
<tr>
<td>I can spend more time helping pupils who need extra attention</td>
<td>4%</td>
<td>25%</td>
<td>56%</td>
<td>15%</td>
<td>167</td>
</tr>
<tr>
<td>I can do my work more efficiently</td>
<td>4%</td>
<td>25%</td>
<td>58%</td>
<td>13%</td>
<td>167</td>
</tr>
<tr>
<td>I like being a teacher better</td>
<td>8%</td>
<td>24%</td>
<td>49%</td>
<td>20%</td>
<td>164</td>
</tr>
<tr>
<td>I have more difficulty keeping track of what pupils are doing</td>
<td>11%</td>
<td>61%</td>
<td>22%</td>
<td>6%</td>
<td>171</td>
</tr>
<tr>
<td>I have more contact with pupils</td>
<td>7%</td>
<td>39%</td>
<td>49%</td>
<td>5%</td>
<td>168</td>
</tr>
<tr>
<td>I have to deal with more problems during the lessons</td>
<td>9%</td>
<td>46%</td>
<td>40%</td>
<td>5%</td>
<td>170</td>
</tr>
<tr>
<td>There is more pressure on me during my lessons</td>
<td>19%</td>
<td>56%</td>
<td>21%</td>
<td>5%</td>
<td>166</td>
</tr>
</tbody>
</table>

There are no significant differences between primary and secondary education teachers’ views with regard to the reactions to the statements listed in the table.

9 Barriers to (the increase of) ICT use in education

In the questionnaire, several potential barriers to (the increase of) ICT use by teachers were listed. Teachers were asked to indicate whether they considered these to be ‘no barrier’, ‘a slight barrier’, or ‘a serious barrier’. Table 18 shows the results. The largest barriers to (the increase of) the use of ICT in education, according to the teachers, are the limited availability of time for professional development and insufficient quality of pre-service training. Two out of three ICT using teachers consider the time available for professional development a serious barrier with regard to using ICT in education, whereas only 4 percent think this provides no barrier. About half of the teacher group consider the quality of pre-service training to have a negative influence on ICT use in education. Other significant impediments to ICT use, according to the teachers, are the (lacking) availability of in-service training (which is considered a serious barrier by 40 percent), and insufficient access to hardware (which is felt to be a serious barrier by one of three teachers).
Rather slight barriers are the quality of in-service training, the availability as well as the quality of educational software, time schedules, and the school organization. The ability of pupils, and the attitudes of the school principal, colleagues, pupils, and parents are no barriers to (the increase of) ICT use, according to a majority of the ICT using teachers.

Table 18 - Barriers to (the increase of) ICT use in education, according to ICT using teachers

<table>
<thead>
<tr>
<th>Barriers</th>
<th>No barrier</th>
<th>A slight barrier</th>
<th>A serious barrier</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>time for professional development</td>
<td>4%</td>
<td>29%</td>
<td>67%</td>
<td>170</td>
</tr>
<tr>
<td>quality of pre-service training</td>
<td>23%</td>
<td>23%</td>
<td>54%</td>
<td>151</td>
</tr>
<tr>
<td>access to hardware</td>
<td>21%</td>
<td>43%</td>
<td>36%</td>
<td>175</td>
</tr>
<tr>
<td>availability of in-service training</td>
<td>28%</td>
<td>32%</td>
<td>40%</td>
<td>163</td>
</tr>
<tr>
<td>quality of in-service training</td>
<td>32%</td>
<td>41%</td>
<td>27%</td>
<td>151</td>
</tr>
<tr>
<td>availability of educational software</td>
<td>36%</td>
<td>37%</td>
<td>27%</td>
<td>176</td>
</tr>
<tr>
<td>time schedules</td>
<td>41%</td>
<td>37%</td>
<td>22%</td>
<td>171</td>
</tr>
<tr>
<td>quality of educational software</td>
<td>39%</td>
<td>42%</td>
<td>19%</td>
<td>173</td>
</tr>
<tr>
<td>the school organization</td>
<td>51%</td>
<td>34%</td>
<td>15%</td>
<td>170</td>
</tr>
<tr>
<td>the ability of pupils</td>
<td>75%</td>
<td>20%</td>
<td>5%</td>
<td>173</td>
</tr>
<tr>
<td>the attitude of colleagues</td>
<td>82%</td>
<td>12%</td>
<td>6%</td>
<td>172</td>
</tr>
<tr>
<td>the attitude of the school principal</td>
<td>89%</td>
<td>6%</td>
<td>5%</td>
<td>170</td>
</tr>
<tr>
<td>the attitude of pupils</td>
<td>92%</td>
<td>6%</td>
<td>1%</td>
<td>172</td>
</tr>
<tr>
<td>the attitude of parents</td>
<td>94%</td>
<td>4%</td>
<td>2%</td>
<td>172</td>
</tr>
</tbody>
</table>

Finally, the teachers were asked in what way the barriers to (the increase of) ICT use in the schools, in their opinion, might be overcome (see table 19). The solution that was mentioned most frequently, regards in-service training. Many teachers think the provision of more, better, or tailored in-service training may help increasing the use of ICT in the schools. This goes especially for the Irish teachers: here 35 out of 48 teachers pointed at the lack of adequate in-service training with regard to ICT use. Quite a lot of teachers think that more funding may help overcoming the barriers to ICT use in the schools. Other solutions mentioned include providing more time for the teachers’ professional development (this was mentioned especially by Dutch teachers), and the provision of (additional or more up to date) computers and software. Some teachers feel providing more information about ICT use might be of help.
Table 19 - Ways to overcome the barriers to (the increase of) ICT use in the schools (numbers and percentages of 120 teachers who answered this question)

<table>
<thead>
<tr>
<th>Way</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>More / better / tailored in-service training</td>
<td>52</td>
<td>43%</td>
</tr>
<tr>
<td>More funding</td>
<td>42</td>
<td>35%</td>
</tr>
<tr>
<td>More time for the teachers’ professional development</td>
<td>22</td>
<td>18%</td>
</tr>
<tr>
<td>More or more up-to-date computers</td>
<td>16</td>
<td>13%</td>
</tr>
<tr>
<td>More information about ICT use</td>
<td>12</td>
<td>10%</td>
</tr>
<tr>
<td>More software</td>
<td>11</td>
<td>9%</td>
</tr>
</tbody>
</table>
Annex 5 - ICT in Belgium

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1. Description of the Flemish education system

1.1 Flanders: an autonomous region in a federal state

In 1830, Belgium became an independent state with a Constitution of its own (1831). From 1970 on, this constitution has been reformed in several steps. Indeed, the political, legislative and administrative structures of the originally unitary and centralized Belgian state developed into a federal system.

In this federal Belgian system, there are three policy levels each with their own legislative and executive bodies: (a) the Federal state which considers matters of common interest, (b) the Communities based on the linguistic and cultural identities, and the Regions which refer to geographical characteristics. There is no hierarchy between these three policy levels since they have each their own responsibilities.

Three Communities exist in Belgium: the Flemish Community, the French Community and the German-speaking Community. They are responsible for the cultural and personal affairs (e.g. education) within a certain linguistic area. Consequently, the Flemish Community is fully responsible for the Dutch-speaking area and partly for the metropolitan area of Brussels, taken into account the bilingual status of the capital. The Regions (the Flemish Region, the Walloon Region, the Capital Region of Brussels) are responsible for matters partly or fully related to a well-determined territory.

Each Community and Region has its own Parliament and Government. Flanders is the northern, Dutch-speaking part of Belgium. Here, the political borders of the Community and the Region coincide. That is why there is one single Parliament of Flanders and one single Government of Flanders.

The recent institutional reforms led to the educational responsibilities being vested in the hands of the Communities (1989). This way, each Community has its own education system, respectively dealing with 57.5 percent (the Dutch-language system), 42 percent (the French-language system) and 0.5 percent (the German-language system) of the overall number of pupils in Belgium.

Within the Ministry of the Flemish Community, the Education Department is responsible for nearly all aspects of the education policy, from nursery school to university education. The Flemish Minister of Education chairs the Department; he is a member of the Government of Flanders. The federal authorities are responsible only for teachers’
pensions, for compulsory school attendance and for determining the minimum requirements to obtain a diploma.

1.2 Certain specific characteristics

Flanders is a small region with a very high number of learners at school (59 percent of the total number of young people in the ages of 2 to 29). Among other things, this is due to the high participation in nursery school, compulsory school attendance from the age of 4 to 18 and the open access to higher education. The compulsory school attendance is from the age of 6 to 18.

There are three educational networks which are largely autonomous:

1. Community education (16 percent of all pupils):
   This is the education organized by ARGO (i.e. 'Autonome Raad van het Gemeenschapsonderwijs' or Autonomous Council For Community Education) on behalf of the Flemish Community. The Constitution forces Community education to be denominationally neutral;

2. Subsidised official education (15 percent of all pupils):
   This includes education at the level of the provinces, organized by provincial authorities and municipal education set up by municipal authorities; a school of this network can be denominationally or not;

3. Subsidised private education (69 percent of all pupils):
   This is education provided by private initiative, a private person or a private organization. It includes denominationally (mainly Catholic), non-denominationally private or specific method education (Steiner, Freinet,..), and pluralist private education.

The networks have extensive autonomy. They are free to choose their pedagogic methods, curricula and schedules, but they are all subsidised by the Community.

1.3 Education levels

Traditionally, three educational levels exist: (a) elementary education (nursery and primary schools), (b) secondary education and (c) higher education (universities included). At the level of elementary and secondary education, special education exists as well; it is meant for children and adolescents with a mental, physical and/or sensorial
handicap, with grave behavioural and/or emotional problems or serious learning difficulties.

1.3.1 Elementary education: nursery and primary school

Elementary education includes nursery school and primary education. Although they are independent with regard to their structures, an attempt is made to obtain a smooth transition between both.

Nursery school is part of the elementary school level and provided for children aged 2.5 to 6. This education is not compulsory though free of charge. Nearly all children attend nursery school in Flanders. Indeed, on reaching the age of 2½ more than one third of all children regularly attend school and this percentage increases from the age of three, reaching more than 99 percent for the 5 to 6 year age group.

Primary education is meant for children aged 6 to 12 and consists of 6 consecutive years. When they finish this cycle, children are granted an elementary education certificate. In most cases, year class systems are used in primary education. Each class has its own grade teacher. In other cases and mainly in smaller schools, grades can be put together in a multi-grade school in which one teacher teaches different grades at the same time.

1.3.2 Secondary education

There is one secondary school system for all educational networks meant for youngsters aged 12 to 18, consisting of 6 years of education. There is great emphasis on basic training. The final choice of the study career is postponed in order to have pupils get to know as many subjects as possible. Part of the study package is equal for all pupils of the same year. This is the collective part. Apart from this, pupils can select several specific subjects; this is the optional part.

Four education forms are distinguished:
- general secondary education (‘ASO’): a broad theoretical education is emphasised here; it provides a solid foundation for attending higher education.
- technical secondary education (‘TSO’): attention mainly goes to general and technical-theoretical subjects. After TSO youngsters can hold an occupation or continue studying in higher education.
- artistic secondary education (‘KSO’): a general and broad education is linked up with practising the arts in an active manner; after KSO, youngsters can hold an occupation or go towards higher education;
- vocational secondary education (‘BSO’): this is a practical education form in which youngsters acquire specific skills and simultaneously receive general education. Under certain conditions, transition towards higher education is possible.

The 6 years of secondary education are divided into 3 levels of 2 years each. The first level consists of the 1st and 2nd year of secondary education. The start of secondary education is split into two separate sections: year A (for all pupils without any learning deficit) and year B (for pupils who are lagging behind, often caused by either longer periods of illness or absence, or learning difficulty). In the 1st year A, at least 27 of the 32 periods a week are devoted to basic training. It is common for all pupils of the same school. In the 2nd year, at least 24 periods are devoted to basic training from which at least 14 are common for all pupils. The first year B in the 1st grade, as mentioned, is meant for pupils with learning arrears or pupils less suited to receive mainly theoretical education. Pupils can either enter the first year A if they succeed or start in the vocational secondary education line. A general scheme on secondary education is presented on the next page.

2. Current policy on information and communication technology in schools

2.1 Introduction

In general the policy of the Flemish Government concerning ICT in education can be described as project-based. The government asks the schools to take initiative and to subscribe for specific ICT calls for tender. Those tenders are evaluated by special ad hoc evaluation committees on several aspects, including the educational added value before they are approved and the schools receive subsidies. It always concerns small scale-subsidies, in most cases ranging from 50.000 to 100.000 BEF (€1.250 - €2.500). The government does not want to push a limited number of schools very explicitly but prefers to support financially rather small initiatives in a large number of motivated schools. The government explicitly chooses a widespread strategy with a snow ball effect.
### Scheme 1: general overview of secondary education in Flanders

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>GENERAL</th>
<th>TECHNICAL</th>
<th>ARTISTIC</th>
<th>VOCATIONAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIRST</td>
<td>1st year A</td>
<td></td>
<td></td>
<td>1st year B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2nd year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SECOND</td>
<td>3rd year B.S.O.</td>
<td>3rd year K.S.O.</td>
<td>4th year B.S.O.</td>
<td>5th year B.S.O.</td>
</tr>
<tr>
<td></td>
<td>3rd year T.S.O.</td>
<td>3rd year T.S.O.</td>
<td>4th year K.S.O.</td>
<td></td>
</tr>
<tr>
<td>3rd</td>
<td>5th year K.S.O.</td>
<td>5th year K.S.O.</td>
<td>6th year B.S.O.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5th year A.S.O.</td>
<td>5th year T.S.O.</td>
<td>6th year K.S.O.</td>
<td></td>
</tr>
<tr>
<td>4th</td>
<td>4th year B.S.O.</td>
<td>4th year T.S.O.</td>
<td>6th year K.S.O.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4th year A.S.O.</td>
<td>4th year A.S.O.</td>
<td>6th year K.S.O.</td>
<td></td>
</tr>
<tr>
<td>5th</td>
<td>6th year B.S.O.</td>
<td>6th year T.S.O.</td>
<td>6th year K.S.O.</td>
<td></td>
</tr>
<tr>
<td>6th</td>
<td>6th year K.S.O.</td>
<td>6th year T.S.O.</td>
<td>6th year K.S.O.</td>
<td></td>
</tr>
</tbody>
</table>

**General:** 7th year preparation year for higher education.

**Technical:** 7th year specialisation year TSO.

**Artistic:** 7th specialisation year KSO or preparation year for higher education.

**Vocational:** 7th specialisation year BSO.
The Ministry of Education has quite a limited budget for supportive projects. The education budget is mainly a ‘salary budget’. Seventy-eight percent of the budget is spent on salaries which are paid directly by the Education Department (approximately 150,000 teaching personnel units). When the salary components in the operational resources of education and the operational payments of the universities are also taken into account, this percentage increases to approximately 85 percent. Unlike in some other countries, in Flanders other Departments (like for instance the Department of Economics or Agriculture) do not directly contribute to educational programmes or projects.

When summarizing the Flemish policy concerning the use of ICT in education, three aspects are important. The first is that the government requires high quality standards of the schools that apply who want to be engaged in an ICT project. The requirements are for instance referring to the complementary value of several new media, the virtual exchange of pupils and the didactic approach with regard to the implementation of ICT in the lessons. A second important aspect is the bottom-up and subsidiary approach of the policy. The schools have to take initiative and they keep the responsibility for the project themselves. The government only provides support. The last aspect can be called the ‘early adopter’ effect. All the projects aim in the long run at an impact on the schools which do not yet participate. The participating schools are expected to be examples of ‘best cases’ for others. Therefore, in some projects the opportunity is offered to the participating schools to present their projects on ‘education markets’ and to announce the project outcomes on the website of the Flemish Community.

Below, several projects are presented that were initiated by the government. In some cases the government is the only initiator, in other cases other partners are also involved.

2.2 Several projects

2.2.1 ‘Internet project’

The initiator of this project was the Education Department itself. The aim was to stimulate the educational use of new media. Schools that wanted to integrate ICT in the teaching/learning process would be supported financially and logistically. In April 1997, the Flemish government issued a call for tender concerning this project for primary schools as well as secondary schools. Proposals were submitted by 379 schools. An evaluation committee of selected experts evaluated all the tenders. The most important criterion used was the well-motivated educational added value of the use of ICT in the participating schools. Other criteria were the integration of the project in the curriculum
and school work plan, the number of teachers at school participating in the project, as well as the number of schools participating.

In July 1997, 175 proposals were accepted by the Flemish government. The total budget was nearly 15 million BEF (€ 375,000). Each school received 50,000 to 100,000 BEF. Various costs were specified. Costs of Internet software and a modem are subsidised with a maximum of 10,000 BEF. Expenses of an account with an Internet provider are subsidised with a maximum of 10,000 BEF. In addition, 20,000 BEF for each participating teacher is provided with a maximum of 60,000 BEF for one school for communication costs. In-service training is subsidised for two teachers per school (maximum 5,000 BEF per teacher). There is also the possibility to put the school website on the official site of the Flemish Community. If schools set up a network they can receive 10,000 BEF allowance for the costs to exchange information and experience about the use of ICT in education. Those projects are running during the school year 1997-1998.

2.2.2 ‘Digikids’

This is a joint project of several public and private institutions, like the Department of Education, the European Commission, the public television channel, a radio-station, a newspaper, several magazines, a bank, Microsoft, ... The aim is to collaborate with the media, the government and some private enterprises to let youngsters become familiar with ICT.

One part of this project consists of television series to inform and sensitise youngsters about ICT. Beyond that, teachers can take courses about the use of Internet for free. The newspapers and magazines which are partners in this project address ICT related issues in general and the project in particular on a weekly basis. This project is meant for teachers and pupils but also for a broader audience. Within this project, three key aspects are addressed. The first is creating awareness through for instance the television and radio programmes as well as the special articles in newspapers and magazines. The second key aspect is training. Teachers may take in-service training with regard to Internet for free. The schools of the teachers who take these courses receive a ‘digi-kit’ with a value of 50,000 BEF, including a free Internet-connection, the software package Microsoft Office ‘97, a modem, Microsoft Frontpage to build a school website and a manual. Finally, the third key aspect consists of acquisition and integration. All primary and secondary schools can apply for a DIGIKIDS-award for a special school project. Also the projects submitted for the ‘Internet project’ can be submitted once more within this framework.
The criteria for these awards were set by the government and the private partners of this project. The most important criterion is the educational added value. Other criteria are for instance the integration of information on the Internet in the lessons, the integration of different subjects and the number of teachers and pupils involved in the project.

All participating schools receive an award (a kind of signboard); 100 selected schools receive Microsoft Windows NT Server software. All those projects compete also for the Microsoft Road Ahead Price in which 6 schools can win an amount of money for hard- and software between 200,000 and 1,000,000 BEF.

DIGIKIDS is also an official European pilot-program of DG XXII within the framework of ‘Netdays Europe 1997’. The different parts of this project are spread over the school year 1997-1998.

Recently it has been decided within this project to do a telephonic survey about the ICT-equipment in the participating schools. In this research data were collected from 678 schools. An important conclusion is that the availability of information technology equipment (PC’s) is not disappointing, but there is a great lack in communication technology equipment like modems. Some interesting data in this respect are reported in table 1.

<table>
<thead>
<tr>
<th></th>
<th>number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>schools with their own website</td>
<td>22</td>
<td>3%</td>
</tr>
<tr>
<td>schools with Internet</td>
<td>112</td>
<td>17%</td>
</tr>
<tr>
<td>schools with PC’s with modem</td>
<td>119</td>
<td>18%</td>
</tr>
<tr>
<td>schools with PC’s with sound</td>
<td>147</td>
<td>22%</td>
</tr>
<tr>
<td>schools with PC’s with CD-ROM</td>
<td>188</td>
<td>28%</td>
</tr>
</tbody>
</table>

(see: http://www.digikids.be/nl/enquete-hoofd.html)

The situation is worse in primary schools as compared to secondary schools. Only 7 percent of the primary schools have an Internet connection, whereas 24 percent of the secondary schools have one.
2.2.3 ‘Educatieve software als ondersteuning in de zorgverbreding’ (educational software and task differentiation)

Twenty-four selected schools of the ones that submitted an approved proposal for ‘zorgverbreding’, i.e. task differentiation (more attention for individual learner needs, inclusion of learners with special learning needs, remediation of learning difficulties, ...) received an additional amount of money of 170,000 BEF to explore the added value of educational software with regard to differentiation and ‘zorgverbreding’. The aim is to use this kind of software in an integrating way and not just as technical remediation in case of learning problems.

Beyond this amount of money for hard- and software and communication costs, the schools are supported by a workgroup composed by members of several academic institutions. The total budget of this project is 7.6 million BEF (€ 190,000).

2.2.4 ‘Evaluatie van educatieve software’ (evaluation of educational software)

The Flemish government installed also a workgroup with teachers and specialists who evaluate educational software. The results of these evaluations will be presented to a broader audience by means of a programme matrix on a CD-ROM.

2.2.5 ‘BITS2’ (Brussels Impulse for Technology and Software at School)

This project has three main aims. The first aim is to provide all schools in Brussels with a PC with a modem so they can use the ‘Brussels OnderwijsPunt’ (BOP) (http://bop.vgc.be). This BOP is the central database and communication server concerning education in Brussels. It is ‘the electronic home port’ of the Dutch-speaking schools in Brussels. The participating schools receive a free computer, while BOP also functions as an Internet provider. The second aim is to support the introduction of software for language-education in the Dutch-speaking schools of Brussels. The last aim is to explore and to evaluate the possibilities that ICT creates to enhance language-education. This project is the initiative of the Flemish Community-Commission in Brussels.
2.2.6 ‘De Rivieren’ (The rivers)

This will be a joint project of the Flemish Department of Education, the official television-station and the ‘Koning Boudewijnstichting’ (King Baldwin Foundation). It is a future project, which has not started yet.

This project wants to give an answer to the question: ‘What can ICT mean for education, particularly with regard to environmental problems?’ The target group for this project are classes of grades 5 and 6 (pupils of the age of 11 and 12) of primary schools. The starting point of this project is that ICT in education is directed to expand the amount of available learning materials, since ICT has to have an added value for the teachers and the learners.

The name of the project, ‘The Rivers’, indicates that the environment holds a central place. Special attention is paid to ‘water’. In this project, the emphasis is on differentiation and ‘zorgverbreding’.

3 The policy for the future

The negotiations about the budget for 1998 were planned to have been finalised by the 15th of December 1997. This was not achieved however, which allows no definite information about the concrete projects that will be undertaken in 1998.

By order of the Department of Education a research to formulate policy recommendations is carried out by some academic instances. The intermediate findings are already presented, be it that they are rather general. An important task for the government will be, according to these experts, to invest in technical equipment. This is a necessary, but not a sufficient condition to stimulate schools to use ICT. This research considers the lack of equipment in a lot of schools as a serious drag on the movement to the use of ICT in education in Flanders.

Another challenge for the government is to efficiently organize technical and pedagogical support for the schools. This research argues for the installation of a specific education centre for ICT. Another problem related to technical and pedagogical support is the lack of appropriate in-service training endeavours. Organizing this kind of training can be an additional task for this new education-centre for ICT.
As stated before, these are some general policy-recommendations stated by a group of researchers. What the exact policy will be for the future is still unclear. It is clear, however, that the government tries to provide each school with ICT-equipment step by step so that in a number of years all the schools will be equipped with computers. This incremental view on ICT innovation seems to guide the efforts of the government.

Nevertheless it seems as if the existing policy of financing schools for ICT remains problematic, due to the very limited degrees of freedom in the budget. It may be questioned whether a more intensive collaboration between several Ministries, business, private organizations and parent organizations could create more momentum for such an intruding innovation as ICT in education. In addition, research on media innovation clearly shows that a mere technology-driven approach never leads to the intended outcomes. Consequently, there is a huge need for an embedded and synergetic approach, in which all actors are involved at the different levels of the school system: learners and teachers at the micro-level, school leaders at the school organization level (curriculum, grouping, re-allocation of teachers’ tasks, administrative and technical support, financing, etc.) and policy makers at the macro-level. Technological environments need to be turned into technological learning environments indeed.

References

Ministerie van de Vlaamse gemeenschap, departement coördinatie (1996). Education in Flanders, factsheet.


Brussels OnderwijsPunt: http://bop.vge.be

Digikids: http://www.digikids.be

Persmededelingen van de Vlaamse Regering: http://www.vlaanderen.be/cgi-bin/
Annex 6 - ICT in Germany

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1 German educational policy concerning ICT

In December 1994 the Bund-Länder-Commission (Federal and Land governments) for education planning and research advancement agreed on a number of guidelines concerning the use of Information and Communication Technology (ICT) in German schools. The central demand is to employ electronic media in the classroom to a larger extent than in the past. Pupils should learn how to use them in a creative and responsible way as well as to question and deal critically with media messages.

The use of ICT is viewed by the Commission as a task for which not only school, but the entire society is responsible. Schools should therefore cooperate with parents and institutions. Furthermore, media education must be incorporated into the general education in schools, and more emphasis should be put on the contents of the media than on their technical development. Thus, the aim of media education is to reach media literacy as a part of pupils’ general and vocational education.

The measures suggested by the Commission include:
- the advancement of pilot experiments in which different concepts of media education for pupils and trainees are tested and judged,
- the advancement of projects in vocational training, the results of which can be related to nonvocational education,
- the implementation of projects to test the use of electronic media for self-instruction and individualized learning,
- the advancement of research concerning the effects of electronic media on learning and social behaviour,
- the documentation and analysis of other European countries’ experience in the organization of media education,
- the analysis of model and research projects of media education as a basis for a possible development of the above guidelines (Arndt 1996:89f).

On this basis, the Ministers of Culture and Education have declared the necessity of a clearly intensified media education, and during their conference in May 1995 they decided that:
- the use of ICT in schools must take account of the pupils’ manifold and sometimes disparate experience and behaviour patterns in dealing with the media,
- curricula and guidelines must further develop and differentiate fields of media educational activity,
- schools need flexible organization of lessons that will allow for project orientated work.
media education should be integrated as a compulsory component into both phases of teacher training.
- teachers’ in-service training is of increased importance due to the fast development of the media (Arndt 1996:90).

2 ICT resources in German schools

The framework which was described above clashes with the actual situation at German schools. Schools have tried to keep up with the technical development of computers, but due to the continuous innovations in that field it has become almost impossible to do so. In 1994, Meyer claimed that not one single school in Germany was using the WWW or other online services of the Internet, and only few schools had international e-mail and news connections. According to Schnabel (1996:76), though, the number of German schools using e-mail came up to over a hundred by 1996. Even if schools have fully equipped computer rooms they frequently do not meet the latest technical standards. Furthermore, having special computer rooms implies not providing each classroom with computers, which means that computer aided instruction cannot be realized in every subject at all times. Classes have to use the computer rooms by turns (Arndt 1996:91).

Obviously, an improvement of this situation would overburden the budget available. But the financial aspect is not the only problem schools have to deal with. As far as the acceptance of the „Information Highway“ is concerned, both Eschenauer (1996:20) and Weidenmann (1996:71) think that the main obstacle is the information monopoly the supervisory school authorities in Germany hold (the Ministers of Culture of each of the Länder and subordinate authorities at a regional level). Free access to the net might undermine the control exercised by these authorities over the subject matters that are being taught and learned at the schools. Another weak point in the implementation of ICT is the quality of the learning programmes on the market. According to SODIS, a German data bank that describes and evaluates courseware, only eighty of 2424 different programmes are recommended as being suitable for school teaching (Tulodziecki et al. 1996:16). Of the ones that were recommended, the majority was aimed at mathematics, basic informatics, sociology and physics education.

Moreover, the general attitude towards computer aided instruction still is characterized by a fair amount of reserve, scepticism and distrust. As Eigler and Seel (1992:5f) point out, the discussion in German-language literature mostly revolves around socioemotional and sociocultural matters. Whereas in the USA the new technologies are believed to help overcome social inequalities, the European tendency is to expect the exact opposite, i.e.
a two-class society, one group being informed and the other group being uninformed (Eschenauer 1996:12). It is even feared that the introduction of computers in schools may produce a complete generation of inactive, unimaginative, solitary and socially uninterested individuals (Eigler & Seel 1992:5).

Some sources also discuss the effects that the stimulus satiation which is supposedly caused by extensive use of ICT may have on the human brain. The supplement to the German weekly magazine Der Spiegel quotes neurologists and psychologists who explain that the computer generation is getting better and better at taking in an impressive amount of information simultaneously, but becoming unable to process abstract, non-pictorial information (Stockinger 1995:119).

Disregarding the real or fictitious effects on the pupils, though, the issue on which everyone seems to agree is the inadequacy of teachers’ training (e.g. Perrochon & Hartmann 1997, Horstkemper 1997:7, Bruhns 1997:52). The fact that teachers were not taught how to use computers for educational purposes makes it difficult for them to implement ICT in their learning environments.

3 Teachers’ attitudes towards ICT in education

The impression we received from conversations with teachers, is that although new technologies are the central tools for almost every job, teachers are often very sceptical about them. Mostly they do not feel that they are able to use computers in the classroom, they do not quite know what to do with them, or why they should use them at all. They were not sufficiently (if at all) trained to use computers and to work with new media and technologies.

During the fourth German-American Dialogue in 1996 (opened by the Bertelsmann Stiftung in 1992, concerning the topic ‘Media literacy as challenge to schools and education’), positive and negative expectations teachers have about the application of media in the classroom were listed (Eschenauer 1996:26ff).

Some of the teachers’ fears were:
- to eventually become obsolete, to be replaced by a computer,
- to lose authority, credibility, control,
- to be put under pressure by constantly having to keep informed about the newest developments of programs which would require additional work to be done in their spare time.
The Impact of Information and Communication Technology on the Teacher

- to experience ‘techno-stress’ or even ‘techno-breakdown’ during lessons,
- to be flooded with information,
- to witness the loss of cultural values and authentic experience,
- to be exposed to undesirable values,
- to see the gap between social groups grow wider.

The positive expectations usually regarded the quality of lessons and the facilitation of work. Teachers seem to expect more freedom in the organization of the lessons and in the teaching methods. They hope that quick and easy access to information offered in the web will help them plan their lessons, and on a more general level will also allow teachers as well as students to broaden their horizons and to make contact with different cultures. The aspect of saving time is therefore considered as important as the learning potential in using ICT. Teachers welcome the possibilities of explanation, presentation and visualization that computer aided instruction yields because they hope that lessons will become more interesting to pupils. Furthermore, according to teachers’ expectations, communication with parents and colleagues and cooperation with authorities and institutions will be facilitated, in-service training and self-instruction on the teachers’ part will be easily organized, and even curricula will be developed and updated with less difficulty.

As far as the pupils are concerned, teachers expect them to show more motivation in an ICT enriched learning environment and to be more willing to prepare for the lessons at home. The work in class may be supported more actively and pupils’ progress and success can be more easily observed. On the whole, teachers hope to become more professional and to improve their image.

Evidently then, teachers show strong feelings concerning the negative as well the potential positive effects of implementing ICT in the schools. Both Eschenauer (1996:28) and Baumgartner and Pyr (1994:12) caution therefore against taking a too extreme and only one-sided position. In order to have teachers reach a more balanced attitude, Eschenauer (1996:34) suggests teacher training, supervision and guidance not only with respect to technical and didactic matters but also to the more general aspect of reflecting on their new role in education.

4 Teachers’ role in computer aided instruction

Unfortunately, there are hardly any German publications on what teachers actually do in their classrooms when they make use of ICT. Among theorists there seems to be a
consensus that an ICT based learning environment should be developed from a constructivist point of view which is based on the assumptions that:
- learning is an active and constructive process,
- learning is situated, i.e. it takes place in a specific situation that constitutes a specific context,
- learning is a process that is highly self-regulated,
- learning is a social process, and
- learning takes place in cooperative arrangements (Gräsel, Bruhn, Mandl, & Fischer, 1997).

A similar point concerning possible models for instruction is made by Astleitner (1997) on the basis of data that were collected in Austria as part of an IEA project. He distinguished between the following instructional models:
1 - reciprocal teaching,
2 - intelligent tutorial systems,
3 - cognitive flexibility,
4 - cognitive apprenticeship,
5 - anchored instruction,
6 - semantic networks,

Most of these are indeed instructional models that were developed within a constructivist framework. The cognitive apprenticeship approach originated from a situated cognition approach; reciprocal teaching is an example of such an approach, while anchored instruction and cognitive flexibility theory are approaches which lead to the construction of ICT based learning environments that conform to a situated cognition, i.e. constructivist perspective.

From this it follows that within a constructivist learning environment the role of the teacher will be different from that in a more traditional learning environment; it will have to change from that of a knowledge teller to that of a tutor.

There are a number of German authors who agree that the use of ICT should change teachers’ roles. Büchner (1994:14), for instance, argues that within an ICT based learning environment, ‘... the teacher’s role will not be to transfer knowledge or to control individual achievement, but to do individual counselling, to manage projects, to organize discussions and to foster social competence’. Likewise Otten (1994:47) assumes that ‘the teacher will not primarily transfer knowledge, his primary task will be to help students learn to learn by giving them support and advice’. And Rissberger (1995:69) is
convinced that ‘in the future, we will need fewer teachers for transfer of knowledge. They will be counsellors and moderators of educational processes. Using multimedia, teachers will have more time to teach social competence and to monitor educational processes’.

These are the expectations expressed in German publications on the use of ICT in school. Up to day, there is, however, hardly any research that is related directly to these issues. Questions are raised as to whether the computer is to be considered the teacher’s tool or the teacher’s substitute, or as to whether it is the teacher’s task or the computer’s task to supervise and instruct (De Corte et al. 1992:29), but these questions are then left to be answered by future studies.

Issing (1994:268) predicts that the function of the teacher will become more and more that of a learning advisor or a counsellor through the application of multimedia systems in education. The author of an article in Der Spiegel (Stockinger 1995:116) describes the tutor of a computer class for 4 to 6-year-olds as acting like a moderator rather than like a knowledge teller. In his account of computer aided teaching in a primary school, Schnabel (1996:74) reassures the readers that the teacher will continue to play the most important role in the lesson, being the one to decide on the proper use of the computer, to set the tasks and to help the weaker pupils. None of these authors, though, gives a more detailed description of the tasks or the behaviour of the ‘new’ teacher, let alone practical suggestions or instructions.

Eschenauer’s article is the one that comes closest to providing teachers with concrete directions on how to deal with the new situation. She claims that teachers stay in charge of the learning process, but the teaching method has to change (Eschenauer 1996:28). The lessons become less teacher centred, and the pupils have to be trained to a much greater degree to set their own pace and to determine their own steps towards the educational target. Teachers have to become interested in teamwork and to learn how to deal with ‘techno-frustration’. By reflecting on teaching and learning situations they need to realize that learning and creative processes gain in importance, whereas teaching and instructing become less essential activities. Pupils must be supported in the autonomous control of their learning process, and teachers must get used to the idea that learning is a lifelong process (Eschenauer 1996:28f).

On the teachers’ way towards media literacy and media education literacy, Eschenauer considers the following steps to be necessary:

- teachers start using ICT in their lessons selectively for things that have to be done anyway and have in the past been done using traditional media.
they start to proceed more specifically, e.g. they design electronic notebooks (i.e. program based note pads) themselves,
they develop and produce multimedia presentations and experience their first frustrations,
they start sharing their experiences with their pupils and thus partially change their role behaviour,
they look for suitable software for their class,
they reach the phase of media education literacy, which means, among other things, that they understand how the use of ICT helps construct individual knowledge and that they are able to convey their understanding to their pupils (Eschenauer 1996:29).

This process is characterized by a growing capacity to regulate one’s own learning processes. According to Eschenauer, these metacognitive skills will vary individually and may be developed through unsystematic ‘learning by doing’, just out of curiosity or by coincidence. But carefully directed training programmes can definitely accelerate the acquisition of metacognitive skills (Eschenauer 1996:29).

In order to make pupils media literate, thus, the teachers have to reach media literacy and media education literacy themselves. Their task, on a general level, changes from imparting knowledge to the pupils to enabling them to use ICT in a competent and responsible manner. But the question how teachers’ roles and actual behaviour during the lessons will differ from that in traditional instruction is hardly touched upon in the relevant literature.

5 The use of ICT in German schools

In most German-language publications the authors discuss how computers can be used in school, what kind of courseware exists, which effects of computer aided instruction on the pupils may be expected and which multimedia projects are currently in progress in schools. As pointed out in the beginning, this discussion in general addresses instruction in secondary education.

We would like to add a caveat: from the literature we reviewed one might gain the impression that there is the German school in which the impact of ICT may be studied. This is definitely not true. The German school does not exist. Due to the fact that matters of education are regulated at the level of the Länder, schools vary from Land to Land. Furthermore, there is at least as much variation within each Land. Also, most of the literature refers to general secondary education schools; little is being said about ICT in
vocational schools and in primary schools. So we only can hope to extract some general ideas, but we certainly will not be able to give a picture that describes the very complex situation sufficiently well.

Haider (1994) analyzes the situation in Austrian schools, and Baumgartner and Payr (1994), also from Austria, present a whole range of aspects from basic information about learning and knowledge to a typology of courseware and to a case study on foreign language acquisition.

Petersen and Reinert (1994), Tully (1994), Issing and Klimsa (1995) as well as Kleinschroth (1996) deal with similar topics, i.e. learning with computers, possibilities and risks of the new technologies in education, and description of learning programmes. Meyer (1994) and Baer et al. (1995) examine the presence and the possibilities of Internet connections in schools and make a number of suggestions on how lessons may benefit from the net.

A variety of literature exists which deals with the classification and the quality of educational software, e.g. Tully (1993b), Stockinger (1995), Tulodziecki et al. (1996), Schulmeister (1996) and Bock (1996), and in some cases particular programs or experiences with programs in particular subjects are presented, such as in Fach-Overhoff (1990) with respect to natural science and in Krauthausen (1994) and Reichel (1995) with respect to mathematics. The great demand for information about courseware can be explained by the fact that teachers and parents feel disoriented and helpless in this field. Some authors try to make a stand against the prejudice that programs just dully question the pupils and cut them off socially (Baumgartner & Payr, 1996:12).

The particular studies realized or described in the past few years are concerned with essentially two issues, i.e. the advantages or disadvantages of program or learner controlled courseware (e.g. Schumacher & Leutner, 1990; Vilsmeier, 1992) and those of pupils working with computers individually or in cooperative settings (e.g. Neber, 1993; Strittmatter et al., 1994). The interest in this last issue again originates in the wish to reduce prejudice against the computer. The widespread fear is that of pupils’ growing isolation and entanglement in the new technologies. Thus, apart from trying to convince people of viewing computer aided instruction as a chance to increase pupils’ individuality, independence and initiative, experiments are carried out to find a way of combining technical and social instruction, i.e. by having pupils work in pairs or groups. Pelz (1995), on the other hand, analyzes the effects of computer conferences on group behaviour.
Those studies which concentrate on the cognitive effects ICT enriched learning environments may have on the pupils usually compare specific qualifications and abilities between ICT-users and non-users (see, for instance, de Corte et al., 1992; Seel, 1992; Tully, 1993a; Hasebrook, 1995; Eschenauer, 1996; Weidenmann, 1996; Perrochon & Hartmann, 1997). Traditionally, lessons are based on books, which means that learning and teaching are sequential processes (Eschenauer 1996:16f). The application of ICT in education causes learning processes to become more individualized and to require more active participation and control on the learners’ part. According to Eschenauer (1996:17), the old learning strategies seem to have become useless, but new strategies have not yet been fully developed.

Sequential and complete reading of texts must be replaced by the ability to quickly collect relevant sources for the information one is looking for. Similar reading and searching strategies are described by Tully (1993a:42) in his article about electronic reference books. Eschenauer (1996:17) sees the danger of merely making pseudo-experiences and of losing the qualities of patience and slowness. Schnabel (1996:74), on the other hand, quotes a primary school teacher who claims that the children actually learn to be patient and persistent by working with the computer. And following Weidenmann (1996:70), traditional reading is only one strategy (which is not to be lost), while data surfing is another. Pupils must learn a whole range of strategies for different purposes instead of just replacing the traditional ones.

Another question which is raised by authors analyzing cognitive effects on the pupils is whether working with computers actually helps pupils acquire cognitive and metacognitive strategies which will facilitate transfer of cognitive skills. Seel (1992:75) comes to the conclusion that working with computers is neither a necessary nor a sufficient condition for the acquisition of particular cognitive skills. Three experiments described by De Corte et al. (1992) demonstrate that cognitive skills will only be acquired and transfer to different situations if the learners were explicitly instructed how to apply the specific skills to new domains. These skills had to be abstracted by the teacher from the context in which they were first acquired, and subsequently decotextualized, i.e. pupils had to be shown in which other contexts the same skills could be of use as well (De Corte et al. 1992:29). This process, though, is not only relevant for computer aided instruction, but also for traditional education. In fact, De Corte et al. refer to the teaching strategies of modelling, coaching, scaffolding, articulation, reflection and exploration suggested by Collins, Brown and Newman (1989) in their work on cognitive apprenticeship, a model that was neither developed from ICT-based instruction nor was it designed for that specific purpose (although the authors assume that it might well be implemented in an ICT-based learning environment).
There are a number of publications that describe multimedia or computer projects that do exist in schools of German-speaking countries. Schnabel (1996:76) indicates the new possibilities of the e-mail connections between pupils of different nationalities: pupils from Aurich for example can communicate with their contemporaries from the Bronx in New York and improve their English. Horstkemper (1997:7) gives the example of the electronic classroom having materialized for teenagers from twin schools in Israel and Germany, who read a book together and exchange their views via the Internet. In the Bücherwurm ('Bookworm') project, children and teenagers choose and review books and present them on their own page on the Internet, impatiently expecting comments and reactions (Horstkemper 1997:7).

Although the use of ICT in German primary schools is still an exception, there are pilot projects at this level. The Beratungsstelle für Neue Technologien (Counselling Center for New Technologies) of the Landesinstitut für Schule und Weiterbildung at Soest in Northrhine-Westfalia has under the direction of Will van Lück created and evaluated a hypermedia learning environment called the green classroom (Landesinstitut für Schule und Weiterbildung, 1993). It is a CD-ROM based interactive hypermedia learning environment that consists of data bases as well as of tools to write and read and to calculate. It is planned to implement also tools to draw and to paint, tools for model building and simulation, and tools for communication. The learning environment allows students to do studies in their natural environment. Possible topics are - at present - singing birds, flowering plants, small mammals, huts, and fire, i.e. topics that are part of the natural environment of primary school pupils.

Schulen ans Netz ('Connecting schools to the net') is the name of a project started by the Federal Education Ministry, Bertelsman Editors, T-Online of the German Telekom, America Online (AOL), and CompuServe with funds of 59 million DM for 10000 schools (Bruhns 1997; Drabe & Garbe, 1997). The basic idea is to make it possible for the participating schools to have access to the information that is stored in the web (WWW) and to exchange information via e-mail. It is also to pave the way for a general German school net. So far, there exist different school nets at the Länder level and fragments of a German school net (DSN - Deutsches Schul-Netz and ODS - Offenes Deutsches Schulnetz).

We would like to note that at present, there is also a European school net under construction: EDUVINET (Education via networks in the European Union). This is being done in the context of a project financed by the European Commission as a Socrates project on Open and Distance Learning (ODL) the basic idea of which is to
promote the use of the Internet for teaching and learning in European schools (Ohlendorf, 1977; for more information, see http://www.merian.fr.bw.schule.de/iwb/).

Schools participating in the Schulen ans Netz (SaN) project have access to a number of servers that provide information which may be useful for teaching and learning purposes: the German Educational Server (Deutscher Bildungs-Server, which may be reached at http://dbs.schule.de) and the Center for Instructional Media in the Internet (Zentrale für Unterrichtsmedien im Internet - ZUM; http://www.lbw.bwue.de/schule), for example. These servers also offer information on many aspects of the German educational system, including information on Internet based projects in school.

Although the SaN project is still in its initial phase, a number of interesting projects are already documented; a study on present day Northern Ireland in the context of an English class (Donath, 1997), the development of a databench of biotopes in a number of European countries (Sarnow, 1997; see also http://baldrick.kc.kuleuven.ac.be/~karls/bionet/), a project on crusades in the middle ages (Currlin, 1997; see also http://http://www.del.emb.net/schulen/gzg/) and another histrory project on European-American history (Bock, 1997; see also http://www.labi.be.schule.de/schulen/tag/). While the aforementioned projects were or are being conducted in regular secondary education schools, there are also projects at vocational secondary educational level (European Travel Agency Project - ETAP, Pannen, 1997; see also http://www.bbsmoers.nw.schule.de) and at primary school level (‘Füchslein’ - little fox, a project for a students’ newspaper in the Internet at a primary school; Küper, 1997, see also http://rhs.schwerte.de).

Another project that needs mentioning is the Comenius project, the first project of this kind worldwide, which enables pupils to experience joint visual learning (Arndt 1996:97ff, Bruhns 1997:50ff). It was planned to be set up by August 1995, but only by January 1996 it was actually functioning (Bruhns 1997:52). Five secondary education schools in Berlin are connected to each other and to data banks via 155-Megabit glass fibre lines. Pupils can learn to produce, administrate and exchange information, photos and diagrams. The aim is for them to be able to teach themselves and others, ask questions, search and propagate answers, because, as is said, no teacher can impart as much knowledge as the data nets (Bruhns 1997:50). A topic for the project had to be found which would be equally suitable for different age groups and for different subjects, and it was finally agreed upon to concentrate on the specific neighbourhoods of the pupils (‘Our block’). This topic can be relevant for history, sociology, economic studies, biology, architecture, art and music. Pupils can collect information and discuss the material during video conferences (Arndt 1996:98). A very basic and practical factor
about traditional teaching which needs to be changed for projects of this kind has already been discovered: the duration of the lessons (Arndt 1996:97, Bruhns 1997:52). The usual 45 minutes are too short. The pupils’ judgment on Comenius is clear: 85 percent of them enjoyed their German lessons more, and 5 out of 24 thought that multimedia instruction enhances the learning progress (Bruhns 1997:52).

Following his account of the Comenius project, Arndt (1996:99) lists a number of questions, one of them concerning the effect of such media systems on the organization of the lesson and on the role of the teacher. He adds that he hopes to get an answer to his questions once Comenius has been carried through and analysed. This, in fact, seems to be the general attitude in the German-language literature at present.

6 References


Annex 7 - ICT in Ireland

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Structure and Purpose of Report

The report aims to present information that will enable the reader to situate the use and implementation of Information and Communication Technology (ICT) in schools in Ireland in context. In addition, research undertaken on the use and effects of ICT in schools in Ireland is summarised.

Section 1: briefly describes the Irish education system at primary and second level;
Section 2: outlines current education policy with emphasis on elements relating to implementation and usage of ICT;
Section 3: describes specific measures and actions taken in relation to the use of ICT in schools and also indicates obstacles to development;
Section 4: offers some examples of schools-based projects that utilise ICT;
Section 5: provides a synopsis of research undertaken on the use and implementation of ICT in schools in Ireland.
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1 Description of the Irish Education System

1.1 Introduction

In Ireland the compulsory schooling period is from the age of 6 to 15 years.

The Irish education system is somewhat unusual in that schools at primary and at second level function, within the limits set out by the Minister for Education, as relatively autonomous bodies, with financial assistance from the state to the majority. The vast majority are run under the auspices of different religious denominations. There are virtually no state owned schools in mainstream primary and second level education. (The closest equivalents are second level schools run under the authority of Vocational Education Committees that are established by local authorities. In 1994/5 32 percent of second level schools were in this category.)

While primary and second level education is formally free, because of the inadequate level of financial support to schools from the state, it is common practice for schools to ask parents for ‘voluntary’ financial contributions to help with running costs. In addition the costs of school books and other materials have to be largely borne by parents in most cases.

1.2 Primary Schooling

While children are legally obliged to attend school from the age of 6 years, in practice nearly all children of 5 years attend and indeed almost two-thirds of four year olds. At the age of 12 years, children normally complete their primary schooling and transfer to second level education.

In 1994/5 there were 3,203 primary schools with 480,000 pupils in the Republic.

The primary school curriculum is based on the following principles:

- The full and harmonious development of the child, with due allowances made for individual differences;
- The central importance of activity and guided-discovery learning and teaching methods;
- Teaching and learning through an integrated curriculum and through activities related to the child’s environment.
These principles reflect a child centred approach first endorsed in the 1971 review of the primary school curriculum. In primary schooling children will normally spend the school day with the same teacher in the same classroom.

1.3 Second Level Schooling

Second level education in Ireland is divided into two cycles. The Junior Cycle is of 3 years duration, normally being completed at 15 years of age (the current minimum school leaving age). The Senior Cycle, of two years duration is then taken, with completion at 17 or 18 years of age. At the end of the Senior Cycle most students sit for the Leaving Certificate examination. A student’s performance in this examination dictates his or her access to third level education and to many occupations. The recent 1995 White Paper on Education promises to raise the minimum school leaving age to 16 years so adding another year to the period of second level education. (This will bring the minimum school leaving age in line with the minimum age for full-time work.)

In 1994/5 there were 775 second level schools in the Republic with a student population of 371,000.

Whereas the primary school curriculum takes a child-centred approach, at second level the approach is more subject orientated. Students will typically have a different teacher for each subject. The pressure for students to get good results in their Leaving Certificate examination constrains much of what happens at second level. Therefore, the scope for experimentation and latitude in the curriculum in second level schools has been very limited.

The White Paper on Education promises a more student centred curriculum, especially at Junior Cycle, but this has yet to happen.

The introduction of a Transition Year programme in the early 1990s, coming between Junior and Senior Cycles, has allowed some space for more innovation and experimentation. In 1995/6 some 500 second levels schools were offering Transition Year programmes.

Diagram 1 shows the relationship between the period of compulsory schooling and the primary and second level education system in Ireland.
Diagram 1 - Structure of the Irish Education System

2 Current policy on Information Technology in schools

2.1 White Paper on Education

The recent (1995) White Paper *Charting our Education Future* sets out the strategic direction for education policy. It is the end result of a lengthy and broadly based consultative process that began with the 1992 Green Paper *Education for a Changing World.*
The conceptual framework underlying the White Paper conceives of education as having a central role as:

'... one of the critical sources of economic and social wellbeing in modern society.'
(Government of Ireland, 1995:5)

and,

'The contribution of education and training to economic prosperity has been underlined in successive national understandings with the social partners and in independent studies carried out, for instance by the National Economic and Social Council and the Organisation for Economic Co-operation and Development.' (Government of Ireland, 1995:5)

Regarding equality:

'A sustaining philosophy should seek to promote equality of access, participation and benefit for all in accordance with their needs and abilities. Measures to promote equality will include allocating resources to those in greatest need, providing appropriate support systems, and changing the tangible and intangible qualities of the system itself to cater for the diverse educational needs and interests of the population. It will include strategies for the earliest feasible intervention to support children at risk of educational failure and will develop specific measures to continue special supports for such children throughout their education.' (Government of Ireland, 1995:7)

Education is not given a broader more proactive role in relation to issues such as poverty, unemployment and social exclusion. However, as O'Sullivan notes, there is an admission that, in many cases:

'Education disadvantage is, in many cases, rooted in wider and fundamental social inequalities and difficulties.' (Government of Ireland, 1995:5)

The theory of educational disadvantage is largely in the deficit mode and the character of interventions proposed focus mainly on compensatory education and stronger home-school links.

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1 This central role may be one outcome of the 1992 Culliton report which stresses a more 'market-led' education system.
2 Whereas in the 1992 Green Paper - Education for a Changing World - the first aim of the education system is 'To establish greater equity in education - particularly for those who are disadvantaged socially, economically, physically or mentally.' (Government of Ireland, 1992:6).
Regarding the use of ICT in schools, the Green Paper stated that:

‘teaching at all levels of the education system must keep abreast of the potential created by new technologies for the process of teaching and learning. The use of the new technologies - for example, computers, interactive video and electronic mail - is likely to be a more familiar feature of classroom life in the future. Equally, it is increasingly important that a basic appreciation and understanding of the modern information and communication technology is fostered in young people, from their early years in school, up to the completion of their education’ (cited in INTO, 1996:20).

The White Paper has not echoed the importance of new technology in teaching and learning to the same extent. It does however recognise that learning strategies based on information and communication technologies are evolving rapidly and should be seen as supporting the achievement of [the paper’s] educational objectives (Information Society Steering: 38). The importance of ICT as a core requirement for students was specifically recognised in the White Paper, which maintains that, on completion of the Junior Cycle, all students would have:

‘... competence and understanding in practical skills, including computer literacy and information technology’. Information technology has become a requirement of both the Leaving Certificate Vocational Programme and the Leaving Certificate Applied. The latter also provides an optional course as a specialist study area.’ White Paper on Education (1995:48)

2.2 ICT in Education Policy

Partly owing to the dearth of a policy in the 1970s and 1980s, Information and Communication Technology (ICT) implementation in Irish schools is undeveloped. The level of ICT penetration in schools varies considerably with some schools particularly primary schools being very ICT active and others remaining totally unaware of ICT. To date ICT development in Irish schools suffers from a lack of coherent planning, fragmentation and under resourcing.

ICT implementation began first at second level in the 1970s. It was not until the 1980s that any attempt was made by the government to implement ICT at primary level.

The main initiative of the Department of Education to implement ICT at this level was a two year pilot project called 'Computers in Education' (1984-1986). Thirty-four ICT
active schools chosen. In the 1980s a computer studies module on ICT was incorporated into the Leaving Certificate (Lower Level) Mathematics syllabus. The module was optional and was monitored separately from the rest of the syllabus. In 1985 the Junior Cycle Syllabus on ICT was introduced. At primary level in the 1980s there was no formal requirement on primary schools to use ICT in the classroom as a cross-curricular resource.

For the early part of the 1990s there was no coherent policy on ICT implementation in schools. In 1990, the Report of the Primary Education Review Body advocated that the Department of Education promote the maximum possible use of ICT in primary schools (1990:102).

In April 1997 policy on ICT was for the first time seriously addressed by the Government when it launched its new technology plan, Schools IT 2000 Programme. The main aim of this programme is to furnish every school with one PC (with Internet access) by the year 2000. The specific objectives of the plan are as follows:

1. to develop and implement a comprehensive national policy on the role of ICTs in Irish schools;
2. to give pupils access to ICT as an integral part of the learning environment;
3. to give teachers access to high quality professional development in relation to ICT;
4. to provide comprehensive advice, resources and support on the classroom integration of ICT in all schools and;
5. to support the school as a resource for lifelong learning on ICT in the community.

The Department has pledged to invest £30 m over five years as part of the Schools IT 2000 programme. The programme overall was positively received by the major teachers’ organizations. The Irish National Teacher’s Organisation considered the programme to be ‘a great advance to bring primary schools into the new millennium’. They warned however that one computer per school was not ‘adequate’ to provide widespread computer education to pupils. Large-scale fund-raising efforts by schools and teachers would still be required.

The general secretary of the Association for Secondary Teachers in Ireland (ASTI) Mr. Charlie Lennon, while also welcoming the proposed programme referred to the results of the union’s survey of second level schools last year which showed that:

- only 38 percent of secondary schools were connected to the Internet;
- only 37 percent had an e-mail facility;
- 26 percent had no computer room;
• 10 percent could not offer computer science because of a poor pupil-teacher ratio; and
• 15 percent had a shortage of qualified computer science teachers (Irish Times, April 10, 1997).

While the Schools IT 2000 programme is indeed a welcome development in the area of ICT implementation in schools the details of its policy strategies have still to be decided. The new Information Society Steering Committee will advise the government on appropriate policies, which will facilitate greater curriculum integration of ICT in education. Based on The Department of Education’s Submission to the Information Steering Society Committee (1996), however, it would seem very likely that future policy initiatives on ICT implementation will favour a decentralised approach based on fostering a sense of ownership of ICT among teachers through pilot (‘pathfinder’) projects which, with the help of the proposed National Technology in Education Unit, will develop an integrated strategy for ICT implementation in education. The Schools IT 2000 Programme will hopefully result in a more controlled evolution of ICT within the schools.

While welcoming the Schools IT2000 document, the Irish National Teachers Organisation (INTO) has expressed some concerns about the initiative. While acknowledging that it is a policy framework, it finds the document is too aspirational, vague, repetitive and lacking in detail and has huge expectations among teachers and schools.¹ For example, schools are treated as a generic grouping in the initiative – no distinction is made between primary and secondary schools despite the freedom and flexibility allowed in the primary curriculum, in contrast to the subject centres second level curriculum. Schools designated as 'disadvantaged' (i.e. serving socio-economically disadvantaged areas) are not treated differently from others. At national level the exact role and function of the IT Policy Advisory and Development Committee has not yet been outlined by the government.

In addition to these general concerns the INTO raises questions under the following headings:

¹ For example, the policy promises that Telecom Eireann (the national telephone network operator) will connect every school to the Internet by June 1998. This seems very unlikely to be realised given that many schools do not have appropriate computers or training.
Technology Infrastructure

Each school should have the freedom of choice with regard to the computer type they will get – this is essential so that schools can build upon and safeguard prior investment in IT.

Schools should be assisted in purchasing legal software school site licences for their schools e.g. can purchase just one set of packaging/manuals but multiple CD-ROMs.

Primary schools need 'high-spec' multi-media machines – not cast-offs and obsolete models.

Skills Infrastructure

Teachers with little or no ICT awareness need to be offered a curriculum-based programme which raises awareness and demonstrates the potential use of ICT in all areas of the curriculum at all class levels. Only practising teachers will have the credibility to convince their colleagues that technology really is an enriching tool in the teaching/learning process.

Certification and accreditation of ICT courses for teachers needs to be addressed.

It is argued that the acquisition of ICT skills by teachers in itself is not sufficient. Any such acquisition of skills must be in a classroom/curricular context.

Support Infrastructure

The IT2000 strategy proposes that part-time IT advisors will be appointed in ten education centres. The INTO regard this provision as very inadequate. In the area of curriculum development and support the INTO recommend that a specialist primary curricular team be made up of seconded primary teachers with curricular, and not necessarily, technical expertise. Crucially an integrated approach is required. The policy will fail if schools have to look to one agency for technical support, to another for software and yet another for teacher training and development.
3 Specific Actions and Measures Around Use of ICT in Schools

3.1 Introduction

As well as the lack of co-ordination at policy level there is also a lack of co-ordination at the level of implementation. The application of ICT in schools to date has been achieved largely by the hard work of individual teachers, inspectors and schools rather than by policy influences. The actions and measures taken in response to the challenge of ICT implementation are discussed under the following headings: funding, teacher training, curricular integration and the scope for innovation, hardware and software provision and supportive actions/measures.

3.2 Funding

Funding for ICT provision in Irish schools is poor and has consistently been biased towards second-level schools. The level of government spending on the Computers in Education project for example, was paltry vis-à-vis its investment in second-level schools. Eamonn O’Murchu, a representative of the Irish National Teacher’s Organisation (INTO), pointed out at the Report on Computers in Primary Education Conference (1986) that:

‘despite having spent £22 million on computing in second level, not a penny has been allocated from central funds to purchase hardware for the primary school project. The entire financial outlay from the Department in the first year of the project was about £8,000.’

The greater expenditure on ICT at second level over primary-level is worrying. The fact that primary schools are largely told to rely on fund raising efforts to secure computer equipment causes concerns on issues of equity. As one leading ICT activist and teacher states:

‘in disadvantaged areas fund-raising is impossible, parents don’t have extra money. There should be exceptional arrangements for disadvantaged schools’ (Parent & Teacher Feb 1997).

Two of the main teacher unions the Irish National Teacher’s Organisation (INTO) and the Association for Second-Level Teachers in Ireland (ASTI) have also expressed concern about the possibility of two-tier system where students from homes that are not ‘technology rich’ are competing with more affluent students who have computers in their homes and whose parents can afford to make sizeable financial contributions to their
children's schools to purchase multimedia equipment. For ICT implementation to be equitable investment policy needs to take cognisance of these inequalities.

Some of the current ICT initiatives sponsored by the Department of Education include:
- Full funding of computer labs and appropriate equipment when a new school is being built or when an old school is being expanded (second level).
- Partial funding is provided to convert accommodation into computer rooms. The cost of computer equipment however, is not covered (primary level).
- At both second and primary levels, the Department provides extra funding for special need schools. In 1995 the amount allocated in secondary and primary schools was £35,000 and £50,000 (due to increase to £450,000 in 1996) respectively.
- Some EU projects are also sponsored at both levels (GLOBE). Extra financial provision is also made at both levels for schools in designated disadvantaged areas (Government Submission to the Information Steering Committee, 1996).

While these initiatives are useful, the fact remains that the lack of adequate funding for ICT provision continues to be a major constraint in the widescale application of ICT in our schools. Take for example the cost of Internet access for Irish schools. The vast majority of Irish schools are not subsidised in installing or in accessing the Internet. The cost of Internet access to schools generally, but particularly for primary schools is prohibitive. It costs £50 to have an extra telephone line installed for the Internet, £120 in rental expenses and £2.30 - £3 per hour usage.

The £30m investment in the Schools IT 2000 programme is however encouraging for the development of investment policy in ICT. Half of the money is to be used to purchase computer equipment. The remaining £15 million will be used for training teachers and for the development of practices and curriculum products to be used in school education programmes. Ten thousand teachers will be trained to use the Internet. Another 3,500 would receive ‘familiarisation training’ for professional development while 600 will be trained as teacher trainers. To compile education materials quickly a pilot project involving 40 ICT active schools is to be established. An Internet site, Scoilnet, is to be set up where teachers can get advice and curriculum materials for classroom usage.

To further increase the level of computer equipment in schools Irish Industry is being asked to contribute the computer hardware it no longer wants (approximately 46,000 systems per annum) to schools.

The Council of Europe recommends that for every 100 pupils there are 33 computers. The business sector’s hardware contribution to schools is insufficient to redress this
deficit. The proposed £30m investment in ICT implementation in schools thus falls far short of the money required to equip Irish schools with adequate multimedia equipment. The problem of adequate funding and resources for the widespread implementation of ICT in schools persists and the expectation that the Department of Education should resource all computer equipment in schools is now acknowledged as unfeasible. In this context future investment policy will have to consider the idea of shared funding of ICT across relevant governmental Departments (e.g. Department of Finance and the Department of Enterprise and Employment).

3.3 Teacher Training

3.3.1 Introduction

Training is often the Cinderella of Information Technology in schools when it should be regarded as essential (Tagg, 1995:65). The Department of Education provided in-service training for secondary level schools teachers and primary teachers in 1971 and 1984 respectively. The majority of teachers however do not have an easy familiarity with ICT. In a survey of post-primary schools in 1990 for example, it was shown that approximately 60 percent had less than two teachers using or involved in computing in their classroom (Hourihan quoted in Morgan, 1995). Currently within the West Dublin Teaching Centre which services approximately a third of Dublin teachers, there are only two ICT specialists. The fact that the majority of teachers had not had any exposure to ICT in their pre-service education is also a worrying factor (NITEC, 1992).

3.3.2 Pre and In-service ICT Training Provision

The pre and in-service teacher training environment in Ireland is very conservative. There is not the kind of training provision in ICT in teacher training institutions that one would expect in the context of the increasingly ICT-oriented world in which we live. There is a lack of consistency in ICT training provision at pre-service level. This has been attributed mostly to the overcrowded teacher training curriculum and the reluctance of faculties to accommodate ‘newcomers’.

In-service courses in ICT are mainly provided by Teacher Centres, the Department of Education, Colleges of Education and University Departments.
The Department usually runs their in-service ICT training courses during the summer. The Department through its Inspectorate monitors the standards of in-service courses.

Teacher Centres having offered ICT training courses to teachers since 1980. Between 1980 and 1986, Drumcondra Teachers’ Centre in Dublin ran 14 ICT courses. From 1982 to 1991 the Blackrock Centre also in Dublin, ran 45 ICT courses. Workshops on ICT and telecommunication facilities are also offered by Teacher Training Colleges.

University Departments offer Masters’ degrees in Education which contain elements of ICT usually in the research module.

Dublin City University (DCU) runs in-service courses for teachers in technology (multimedia curricular course, ICT in the classroom) as well as organising seminars, conferences and workshops on ICT. In 1996 DCU established the first Masters in Science Course in Computer Applications for Education in the country. This course is part-time and runs over 18 months. Graduates of this course it is expected will be influential in planning strategic and policy issues on ICT.

Staff in-service days are another source of training. Second-level schools are permitted to take one day per year to organize local programmes of staff development. They may opt for an ICT in-service day (NITEC, 1992:31).

3.3.3 Open and Distance Learning Initiatives in ICT

Open and distance learning initiatives (ODL) in Information Technology for teachers are also becoming more popular. One example of such an initiative is EDUVINET - Education Via NETworks. The aim of the project is to promote the use of ICT and electronic networks in classrooms by teachers. Ultimately the project hopes to establish an Eduvinet server and produce a Europe-wide manual outlining models of good computing practice in the classroom. Eight educational institutions European-wide are participating in this project. The Teachers’ Centre Drumcondra is the Irish representative.

APPLAUD - A Programme for People to Learn at University Level at a Distance is a similar ODL-style project. The objectives are to foster co-operation between teacher education institutions across Europe, to promote good ICT practice among teachers, educators and student teachers by establishing a system of ODL modules to be used by training staff and trainee teachers. University of Limerick is a partner in this project.
The Community Across Borders using Information Technology (CABUIT) programme is the most recent Irish ODL initiative established (January 1997). Project partners include Ireland, Northern Ireland and Belgium.

3.4 Curriculum Integration and the Scope for Innovation

Curriculum integration in the Irish school system began in earnest in the 1980s. In the senior years of second level a computer studies module on ICT was incorporated into the Leaving Certificate Lower Level Mathematics syllabus. The module was optional and was monitored separately from the rest of the syllabus. Students who complete the module successfully are nominated by their school to receive certificates from the Department of Education (NITEC, 1992:36). In 1985 the Junior Cycle Syllabus on ICT was introduced. It aimed to familiarise pupils with their school’s computer system and to give them an appreciation of the role of computing (ibid.: 34). There was no formal requirement on primary schools to use ICT in the 1980s although some schools were innovative in their attempts to integrate ICT into the classroom.

The Information Technology Integration Project (ITIP) (cited in The Government’s Submission to the Information Steering Society Committee, 1996) showed that the highest usage of ICT in post-primary schools was in Computer Studies classes (33 percent). Other high areas of ICT usage were in Technical Graphics, Business subjects and Technical Subjects. To a lesser extent ICT was used in Mathematics and Career Guidance. Word-processing, databases, spreadsheets, type tutor and programming were the main applications used. Most study is of computers rather than with the technology.

The 1992 report, New Technology in the Irish School System, stated that ‘since the 1980s the primary school curriculum had elements of integration not there in post-primary schools - drilling, practice, desk-top publishing and word-processing’.

While ICT is used more at second level the degree of ICT integration is, and always has been greater at primary level. This is due to the relatively flexible curriculum design at primary level vis-à-vis the strict curriculum model at second level. The fact that primary teachers have an overall knowledge of the curriculum whereas secondary school teachers specialise in a specific subject also helps explain the greater level of ICT penetration at this level.

Although second level schools have greater curriculum constraints than primary schools in implementing ICT in the classroom there is scope for curriculum innovation. Take for
example the implementation of the Transition Year Programme in 564 schools in the Republic since 1995. ‘Unlike other programmes, there is no written curriculum for the Transition year; rather, within the parameters of Departmental Guidelines, teachers develop their own courses and course content’ (ASTI, 1996:2). If the curriculum at second level can innovate to this extent then surely there is hope for greater curriculum innovation in ICT integration at this level in the future.

The impact of ICT in Irish schools is greatly undermined by the lack of definition on the role of ICT in schools as well as the lack of curriculum guidelines on how ICT could be applied.

3.5 Hardware

3.5.1 Overview

The lack of adequate hardware is a serious constraint on the widespread implementation of ICT. The European White Paper on Education and Training (1996) observed that ‘the penetration rate of educational multimedia at school is still too slow. The quality of products available today is not yet good enough to prompt teachers to use multimedia techniques...’ In addition teaching staff do not always have the right type and the right amount of hardware’ (18).

Lack of standardised hardware was identified in the NITEC and Forbairt reports as being a serious problem obstructing teachers’ involvement in ICT. The reports found a considerable proportion of the hardware in schools was not suitable for adaptation to information networks for multimedia activities thereby undermining the idea of the computer as an aid to learning in a variety of subject areas (ASTI: 1996:9).

The ITIP research found however that there was a low correlation between ICT usage in schools and the existence of appropriate hardware (and software). It found that factors like teachers’ attitudes and their pedagogical and ICT skills were more important factors in determining the level of ICT usage in the classroom rather than the availability of hardware.
3.5.2 Availability and Suitability of Hardware at Second Level

In 1990 an average of 15 computers per post-primary school was indicated in a national survey in Ireland (Hourihan quoted in Morgan, 1995). In 1995 the average number of computers was twenty-two.

The Government’s Submission to the Information Society Steering Society (1996) showed that there was an estimated three machines per 100 students in second-level schools. Much of the equipment in use however is unsuitable for running modern multimedia applications: only 10 percent of schools surveyed have CD ROMS, only 34 percent have modems. Girls only schools had less computers - an average of 16 computers per school.

3.5.3 Availability and Suitability of Hardware at Primary Level

The Report of the Primary Education Review Committee (1990) and the 1992 report New Information Technology in the Irish School System indicated that approximately a third of primary schools had computers.

More current figures on computer provision in primary schools are given by the Irish National Teachers Organisation (INTO) 1996 survey, which showed that 65 percent of primary schools had computers. This is an average of one machine per 100 pupils in primary school. Just over a quarter of these schools got funding for these computers from the Department of Education. The majority of computers however were purchased through fund-raising exercises. As at second level, boys’ schools have better provision for workstations than girls’ schools (Lewis and Kellaghan, 1993:24). Acorn and Apple Mac computers predominate in primary schools.

3.6 Software

The creation of relevant software has been another hurdle in the development of ICT in Irish schools. The majority of software (approximately 80 percent) available to schools is of American origin and the remainder is primarily from the UK. Teachers want to be able to access software packages that are culturally and educationally specific to the Irish situation yet the commercial software industry considers the Irish market too small to be profitable. It is a ‘Catch 22’ situation. In this context there has been a tendency for teach-
ers to be ‘passive’ users of technology having ‘little input into the design, content or modus operandi’ of technology.

The fact that there are no independent, impartial standardised guidelines available to teachers intending to buy hardware and software is another deterrent to ICT implementation. The only published guidelines available are in a magazine called Primary Computing. There is no equivalent magazine at second level. Commercial companies’ motives understandably are profit rather than education oriented. While some teachers have been innovative in creating software these have been in the minority.

3.7 Supportive Actions / Measures

- One of the first responses to the challenge of ICT implementation in schools was the ‘Computer Education Society of Ireland’ (CESI) established in Dublin in 1973 by a voluntary group of teachers. Their aim was to promote information technology in primary and second-level schools by supporting teachers involved in educational computing. In 1988 the CESI began to run non-competitive computer fairs which gave pupils an opportunity to show via computers, the work that they had done during the year. CESI now has branches nation-wide and holds conferences on computing in education and runs in-career development courses in ICT.

- European initiatives like the National Information Technology in Education Centre (NITEC) based in Dublin City University (DCU) was founded in 1988. NITEC is the Irish part of Euryclee, the aim of which is to promote the exchange of ICT information across educational institutions in the EU. It makes information available to schools within Ireland and Europe through its electronic mail and database services as well as through its printed NITEC news. Currently it provides a server for 400 schools, which facilitates connection to other servers and provides information on courses.

- Joint Academia/Industrial Initiatives: The Irish Tech Corps: Tech Corps was established in Ireland in 1996 on a three year pilot programme basis. Its aim is to promote and support the widespread use of technology within the primary and second-level schools. The project involved the collaboration of the Irish Software Association and the Centre for Teaching Computing in Dublin City University. This integrated initiative involves approaching companies and asking them to recycle 486 computers into schools. Volunteers from industry help teachers learn ICT skills. Teachers are given technical, educational and administrative support. The Tech Corps initiative has equipped eleven schools with networks and computer labs. Twenty more are proposed in 1997.
• **Teacher Computing Support Groups:** Since the end of the 1980s many ‘self-help’ groups were established throughout the country to help teachers (at all levels) who were using computers in the classroom. ‘Their activities range from organising their own in-service courses and meetings to producing their own publications’ (NITEC, 1992:34). One example of these groups is the Primary Teachers Computer User Group in the West Dublin Education Centre (WDEC). This group, a group of primary school teachers from several different schools, meet on a fortnightly basis to discuss practical ways technology can enhance education. This group also lobbies for effective policies and legislation on ICT implementation. Another active support group for teachers is Grupa Muinteoiri Riomhairechta Oirthear Corcaí.

• **EdNet Ireland:** EdNet Ireland is an educational website for primary and secondary schools. It aims to increase Internet usage as an educational resource within schools. EdNet offers two main resource sites, one, which helps schools publish material to the web and another, which acts as a resource site in reference to particular classroom subjects. The web site is hosted by BROADCOM, a telecoms research company. Together with the creators of EdNet it has produced a book *Classroom of the Future: A guide to using the Internet in Irish schools.* This book gives practical guidelines for using the Internet. Currently 400 primary and secondary schools are active on the Internet.

• **Primary Computing:** Primary Computing is a magazine for primary school teachers involved in ICT integration in the classroom. It has an educational rather than a technical focus, and features articles on current computing practice in primary schools. It also reviews hardware and software for schools as well as reporting on CESI news.

4 Schools Based ICT Projects: Some Examples

4.1 ICT in the Primary School Curriculum

Some primary schools have been particularly innovative in applying ICT in the classroom. The following case study of Coolerry National (Primary) School in Co. Offaly is an example of the how ICT has and can be successfully used in the primary school system.

**The Coolerry National (Primary) School in Co. Offaly**

This school was designated a Centre of Excellence by Siemens Nixdorf and Microsoft. The Principal Mr. Paddy Bates advocates that ‘pedagogy leads and technology follows!’ Each class in the school does an educational project using ICT as a resource:
Infants class (first 2 years of primary schooling): In infants class booklets on themselves using child-based word processors and a concept keyboard have been produced. The children also plan to use an on screen concept keyboard called 'Clicker'. This will help them do word processing programs without typing.

First and second classes (years 3 and 4 of primary schooling): These classes use authoring programs like Hypercard and Hyperstudio, to produce booklets on a variety of topics. Students also correspond with a school in Australia as well as using Microsoft Word to reply to their penpals in France.

Third class (year 5 of primary schooling): Third class produce software programmes like An Bradan Feasa. Pupils drew illustrations for the story on paper. These were then scanned into the computer (Hypercard) and coloured using KidPix. The project won the award for the best overall entry at the CESI Student Computer Fair in 1994.

Fourth and fifth classes (years 6 and 7 of primary schooling) These two classes have produced Hypercard stacks (books) on the Normans and other themes. In the senior classes many ICT projects have also been devised e.g. Coolderry Local Study Project. This project is based on the history of their locality and was worked on by nineteen fourth and fifth class students, under the guidance of their teachers. For the project students studied local maps, field monuments, castles, churches, saints, schools, townlands, estates, historical figures and chronology. Again Hypercard and Hyperstudio are used to display the final project.

Sixth class (eight and final year of primary schooling): Senior classes are also involved in Internet, Intranet and E-Mail projects. As part of the Globe Project with schools all over the world, they collect weather data each day and send it to Colorado. This data is used to make weather maps and to stimulate a meteorology service. The school is also involved in the POLLEN project (involving seven Irish schools) on a NITEC site. This project links peripheral areas on the west coasts of Europe and aims to improve Irish children’s appreciation of their Irishness but also their sense of European Citizenship. The senior class also present projects at Computer Fairs.

The Sacred Heart Senior National School in Killenarden in Dublin
This school was also designated a Centre of Excellence in Computer Education. A noteworthy aspect of this school is its plan where each class from third class through to sixth class has a specific adventure game offered to them, e.g. Granny’s Garden and Nature Park for third class etc. On the successful completion of these games students
receive an Achievement Certificate for Adventure Games which are personalised by incorporating scans of children's photographs with the text.

St. Michael's Boys National School, Trim, Co. Meath
This school has used games like Sherston's Arcventure III - The Vikings to great effect. This game allows pupils to take part in an archaeological excavation based on a real site. They ‘discover’ artefacts, and are given information about what each is, and how it can be used. The game supported and complimented aspects of the curriculum. The class teacher got the class to do a project on the Vikings in Ireland. In art, pupils made paintings of Viking longboats. In Geography the trade routes followed by the Vikings were examined. The class also made contact via e-mail with the Norwegian based Viking Network. This is a network of schools that had been touched by the Vikings.

St. Michael’s Boys National School also takes part in the annual poetry on-line week. This is organized by Campus 2000 (British Telecom’s major UK-based world-wide education network) The organizers of Campus 2000 send electronic messages every day of the activity week which contains a sample of a style of a poem (e.g. poems based on similes, alliteration, feelings etc’). The style is discussed in class and the pupils write their own poems in the same style. When poems are completed, the best ones are sent via email to Campus 2000 for inclusion in a book of poems on Poetry On-line to be published by Campus (Primary Computing, Jan 1995).

Carnacon National School, Claremorris, Co. Mayo
Senior classes under the direction of their school Principal, undertook a project to write books for Junior classes. They composed and printed stories using Microsoft’s Creative Writer on a 486 PC. This writing tool contains an option which allows pupils to print icons of certain words along side the words themselves thus enhancing their appeal to young readers.

Dunderrow National (Primary) School, Kinsale, Co. Cork
Second, third and fourth classes in this school compile a monthly newspaper using ‘Pendown’. From working on the newspaper, pupils learn editing and layout of a document production. The classes also produce school yearbooks using the same method.
4.2 ICT at Second-Level

The AIB Schoolsave Project
The AIB Schoolsave is a computerised Banking system provided free service to every secondary school in Ireland. The Schoolsave software, technical product back-up and all necessary stationary are provided free of charge. All that is needed to set up a Schoolsave Bank in a school is the necessary hardware. Schoolsave is designed to run on IBM/PC machines, BBC machines, or Apple II Computers. It is specially designed to be operated by students from the school, with minimal teacher supervision. Through operating the Schoolsave Banks, pupils will receive experience of commercial business skills, business computer and keyboarding skills, job responsibility and working as part of a team (Primary Computing, January 1995:13).

The Spin-A-Web competition organized by Trinity College Dublin (TCD) presented second-level schools with the challenge of designing their own home page for the Web. To put together a successful entry required a combination of skills:
• brainstorming skills to decide on the focus on theme
• team work skills to allocate and co-ordinate work
• research skills to locate appropriate information (from both the Internet and from conventional information resources)
• writing and editing skills to produce the text headings and content
• artistic and design skills to plan the page layout and appropriate graphic illustrations, and finally,
• computer skills to bring it all together using HTML (Hypertext Markup Language).

(This example was taken from the Government’s Submission to the Information Society Steering Committee, 1996).

Second-level schools also have the opportunity to creatively use the Internet as a cross curriculum resource. The following are just a few examples of where students can access information relevant to their studies:

ICT in the Geography Classroom
ACERT was produced by students for the CE SI Student Fair. Students studying for the Junior Certificate geography examination can test their knowledge on the different topics of the course. This software was produced using the BASIC language and utilised a question and answer methodology to pursue their goal. On completion of the topic the student was informed of their ability and if further work was required (CTC, 1995:10).
4.3 ICT for Special Needs Students (i.e. students with physical and sensory disabilities)

For students who have a physical and/or sensory disability assistive technology in the classroom has been invaluable. ‘Augmentative communication devices enable those who cannot speak to voice thoughts and needs using touch or light activated keyboards coupled to a synthetic speech system. Screen reading programs (comprising of a software program and a speech synthesiser) for the blind, screen magnification systems (e.g. ZoomText in DOS and Windows) for those with low vision and special ability switches (e.g. a sound activated switch) that permit the mobility impaired to use a computer are only a few examples of the technology by which people with disabilities gain access to the computer screen and keyboard (CTC, 1995:42).

5 Research on information and communication technology in education in Ireland

5.1. Introduction

Research in Ireland on the impact of information technology on teachers, schools and particularly on pupils is undeveloped. There has been very little published research on these issues. This may partly reflect the extent of the relatively undeveloped use and role of ICT in the classroom. Nonetheless, the limited research that has been undertaken makes a contribution to our understanding of the impact of ICT on teachers.

5.2 Synopsis of Research

5.2.1 Teacher Training Provision in ICT

Studies by Gallagher (1995) and Gash (1996) on pre-service training provision in ICT for teachers illustrate the lack of appropriate training in ICT for student teachers. In Gallagher’s study three of the five Colleges of Education are surveyed on the level and type of pre-service training in ICT they provide for trainee teachers. The findings show that training colleges prioritise ICT differently and that there is no minimum standard of ICT training required for teachers at pre-service level. For example in only two of the three Colleges is ICT compulsory. In the third college however all students do an introductory course in word-processing. In one college training in ICT is provided in every year of the students training, while in another students get a total of 12 hours formal ICT training
in second year, and in the third college a mere 15 percent of students participate in an optional ICT course in third year.

The survey also showed that a core set of ICT skills is not being taught to student teachers. While all students have experience of word-processing, adventure games and LOGO, only in one college did students have experience with spreadsheets, database, content-free software, multimedia and e-mail.

Dr. Hugh Gash’s survey of student teachers’ views on their training on ICT was ‘damning’. Students were dissatisfied with their training. Three of their comments illustrate this point:

‘What training?’
‘Had I not been aware myself of the potential use of technology my training would have diminished my wish to use it!’
‘I think that in relation to computers our teacher training is very weak. I have very little knowledge about it [i.e. new technologies of communication].’

The main constraint in using ICT in the classroom identified by trainee teachers in this study was their lack of confidence and knowledge about the new technologies of communication. Despite this however they were positively disposed towards the implementation of ICT in the classroom.

We would love now to be able to prepare children for this ever changing world that we live in. I would like to bring children one step on the way of their development in this area.

The fact that they [i.e. ICT] play such a large part of today’s world would indicate a need for developing children’s competence in their use.

**In-Service Training Provision in ICT**

In the INTO study The Professional Development of Teachers (1994) 432 teachers’ views on in-service education were surveyed. When teachers were asked to prioritise study areas in in-service provision they would like provided at local level the highest percentage of first preferences (54 percent) was in computer technology. This illustrates the level of teacher support for, and belief in, the need for widescale ICT implementation in the classroom.
5.2.2 Teachers’ Views and Attitudes towards ICT

A number of research studies have been conducted into teachers’ views on, and attitudes towards, ICT implementation in Irish schools. The Information Technology Integration Project, for example, documented the views of over 600 second-level teachers. Three principal barriers to ICT implementation identified by the research participants were the lack of curricular integration, lack of adequate training and lack of time.

In a study of 43 primary teachers who attended an in-service summer course on computers in education it was found that approximately four-fifths (82 percent) believed that pupils should be ICT competent. Just over three-fifths (61 percent) of respondents felt there were not enough teachers competent in ICT to train their colleagues. A majority of teachers (84 percent) believed that teachers should be trained in ICT once a year ideally during a week in school term. Most teachers (97 percent) believed that teachers with good ICT capability should be seconded to teach other teachers. Approximately thirty of the forty-three teachers surveyed (70 percent) believed that all teachers should have expertise in ICT and most (79 percent) thought that teachers should have a qualification in this area. Only one respondent strongly felt that there was too great an emphasis on ICT in the curriculum.

The obstacles to the successful introduction of ICT identified in this study were insufficient machines in schools (45 percent), lack of Department of Education Policy (37 percent) and inadequate training for teachers in ICT (12 percent) (see table 1). Other barriers included teacher disinterest, lack of support from school inspectors, board of management, principal and teacher centres.

The main strategies recommended by teachers to deal with these obstacles were direct funding to schools (52 percent), the creation of a school ICT co-ordinator (25 percent) and the development of regional resource centres (17 percent). Other strategies referred to were the development of teacher centres (5 percent) and the availability of a regional ICT co-ordinator (2 percent).
In a study by Morgan (1995) of 50 principals and teachers in charge of computing in Irish schools the main barriers to widespread ICT usage identified by principals were lack of time, lack of hardware and fear and hesitation of teachers. Teachers in charge of computing however cited lack of time and lack of finance as being the main barriers to the cross curricular integration of ICT.

Gash’s study (1996) assessed teachers’ views on ICT implementation and found that they were overwhelmingly positive. When for example they were asked to compare traditional methods of teaching writing with the communicative method the overall finding was that the communicative method of writing contributed positively to pedagogy.

‘Traditional methods are still the mainstay for most teachers, but the communicative method adds variety and enthusiasm’

‘Modern Technology levels the playing field’

‘IT teaches the children to be more structured in their approach to writing and editing. Attention and memorisation also show marked improvement’.

This study found that teachers’ perceptions of their role had not been adversely affected by applying ICT in the classroom. In fact this study found that teachers felt more motivated and effective in their work as a direct result of using ICT. Again teachers observed that their teaching role now, was more like that of a ‘guide’ or ‘director’.

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**Table 1: Main Obstacles to Successful Introduction of ICT**

<table>
<thead>
<tr>
<th>Obstacle</th>
<th>% of First Preferences</th>
<th>% of Second Preferences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insufficient Machines</td>
<td>45</td>
<td>28</td>
</tr>
<tr>
<td>No. Dept of Ed. policy</td>
<td>37</td>
<td>15</td>
</tr>
<tr>
<td>Inadequate training</td>
<td>12</td>
<td>35</td>
</tr>
<tr>
<td>Teacher disinterest</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>Inspector unsupportive</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Board of Management unsupportive</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Principal disinterest</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>no teacher centre support</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

(Source: Gallagher, 1995:66).
‘The teacher guides the pupils’

‘The pupils are active learners, the teachers facilitators’

‘[The] teacher gives assistance and guidance as required’

The pedagogical task of the teacher is unchanged (ETUCE:6). Two leading ICT advocates and teachers corroborate this assertion:

‘The role of the teachers hasn’t changed with the advent of multimedia. [Teachers act as a] facilitator/person who helps the message come across and it is up to the teacher to decide how to use pedagogically’ (Paddy Bates, Principal of Coolgerry National School, Co. Offaly).

‘The curriculum still has to be taught. Technology is another resource. The teacher sets up the learning situation therefore it is easier for the teacher and learning is more effective’ (Robbie O’Leary, teacher in Sacred Heart Senior National School, Killenarden, Dublin).

Research findings illustrate that the response of teachers to their role of guide to autonomous learning is good. For example in Gallagher’s study (1995), teachers were asked to evaluate the effects of ICT on their work. A majority stated that using the computer made their work more interesting while there was also strong support for the notion that the computer motivated pupils and therefore made a teacher’s job easier (see table 2). Third place in the ranking was support for the proposition that pupils benefited from using ICT (1995:76). A significant number of teachers also felt that ICT made their teaching more effective while a small number felt that computers made little difference to their work.

<table>
<thead>
<tr>
<th>Table 2 - Effects of Computer on Teachers Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effect</td>
</tr>
<tr>
<td>makes work more interesting</td>
</tr>
<tr>
<td>it motivates my pupils more</td>
</tr>
<tr>
<td>my pupils benefit</td>
</tr>
<tr>
<td>teaching is more effective</td>
</tr>
<tr>
<td>makes little difference to my work</td>
</tr>
<tr>
<td>it makes my work more difficult</td>
</tr>
</tbody>
</table>

(Source: Gallagher, 1995: 77)
When research participants were asked how they thought children learnt computer skills best the majority responded ‘in small groups with teachers’. So must teachers think that while the role of technology in education is important it has by no means usurped their role as guide and coach to learning.

Table 3 - How Children Best Learn Computer Skills

<table>
<thead>
<tr>
<th>Method of learning</th>
<th>Mean Rank</th>
<th>% of First Preferences</th>
<th>% of Second Preferences</th>
</tr>
</thead>
<tbody>
<tr>
<td>In small groups with teachers</td>
<td>1</td>
<td>44</td>
<td>38</td>
</tr>
<tr>
<td>On individual basis with teacher</td>
<td>2</td>
<td>49</td>
<td>22</td>
</tr>
<tr>
<td>With their classmates</td>
<td>3</td>
<td>2</td>
<td>30</td>
</tr>
<tr>
<td>On their own with the computer</td>
<td>4</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>As part of class with teacher</td>
<td>5</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

(Source: Gallagher, 1995: 75)

In response to a gap in existing literature Morgan’s research (1995) addressed the management activities, aspirations and attitudes of persons in charge of computing in Ireland. These persons he terms IT co-ordinators. He believes that the emerging role of IT co-ordinator is central to the development of computers in education. His survey of IT co-ordinators in second-level schools found that IT co-ordinators were predominantly male (75 percent), had an average of seven years experience in the position, were concentrated in the 41-50 years age bracket, taught in boys or mixed schools and had mainly scientific qualifications (63 percent). Half of those surveyed regularly read computer magazines (100-101).

Co-ordinators in Northern Ireland and in the UK according to North (quoted in Morgan, 1995:22) are involved in maintaining the school’s network, providing support and training staff, software evaluation, formulating school ICT policy, requisition of all hardware and software, production of classroom materials and school administration. The role of ICT co-ordinator thus can be conceptualised under four headings:

1. Computer facilities manager
2. Working with other agencies
3. Working with teachers, and
The most reported intangible benefits of the job Morgan found, was that computers had a strong motivational effect on students. While less attractive aspects of the job included the fact IT co-ordinators are not recognised by the Department of Education (ibid:102) in terms of compensation for the work they do. Some 63 percent of those surveyed were not compensated for the work they do in terms of money or time off. Morgan argues that the emerging role of IT co-ordinator be should be officially acknowledged either by extra pay or time in lieu. IT co-ordinators called for greater in-service training in ICT for themselves and for more school-based in-service training.

5.2.3 Impact of ICT Usage on Students

While there is an abundance of anecdotal evidence on the cognitive and social benefits of ICT to pupils there has been no major Irish research study documenting the precise impact of ICT on pupils. One consistent finding from the limited research available to us however, is that ICT makes students more motivated in their studies. For example in Gash’s research (1996) on the impact of ICT, teachers were asked to compare the involvement of the children in their learning prior to, and after using the new technologies of communication (NTCs), the main finding was that NTCs made children more motivated in their work.

‘They are very involved now’

‘Children get involved very quickly in the technology and often are found working through their breaks without even thinking about it’

‘Project work involves children directly’

Gallagher’s study (1995) as we saw earlier also alluded to the greater motivation of students for study when using the new technologies of communication (NTC).

Gash (1996) also asked teachers to assess the social-emotional effects of the use of technology in children’s education and found that using the NTCs resulted in ‘great social benefits and good preparation for the future’ for pupils. One teacher commented that ‘the children are more emotionally and socially aware of twenty-first century workplace which will involve computers’ while another asserted that NTCs gave ‘weaker children a greater opportunity to feel a sense of achievement and to work at their own pace’. Another distinct benefit of pupils’ use of ICT identified was that it fostered greater ‘co-operation’ in project work.
A small scale evaluation study was conducted by the East Cork Primary Teachers’ Computer Study Group on the benefits of an integrated learning system (ILS) called the Talking Computer Project. In this project a wordprocessor gives instant feedback from the computer which provides cues for the correction of writing, reading and spelling. Incorporating speech with word-processing provides a multi-sensory approach to phonic development using ICT. The objective of this approach was to help children achieve a literacy level where they could take control of their own learning situations with ICT. The project was tested on thirty sixth class primary school pupils who had learning difficulties. While the assessment is ongoing, the initial indications are that the project does improve learning opportunities for students.

Table 4 - Contribution of ICT Supported Learning to Reading

<table>
<thead>
<tr>
<th>Pupil</th>
<th>Reading Age (Before Project, June '95)</th>
<th>Reading Age (After Project, March, '96)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yrs-months</td>
<td>Yrs-Months</td>
</tr>
<tr>
<td>Pupil A</td>
<td>9-0</td>
<td>11-7</td>
</tr>
<tr>
<td>Pupil B</td>
<td>10-4</td>
<td>12-1</td>
</tr>
<tr>
<td>Pupil C</td>
<td>9-6</td>
<td>12-10</td>
</tr>
<tr>
<td>Pupil D</td>
<td>9-9</td>
<td>12-11</td>
</tr>
<tr>
<td>Pupil E</td>
<td>10-11</td>
<td>12-7</td>
</tr>
<tr>
<td>Pupil F</td>
<td>9-9</td>
<td>13-0</td>
</tr>
<tr>
<td>Pupil G</td>
<td>9-4</td>
<td>9-4</td>
</tr>
</tbody>
</table>

Average Improvement - 2 years 3 months

(This example was taken from Parent & Teacher, October, 1996: 21)

The average improvement in the spelling age for these pupils for example was seven months. One of the eight school’s experience of the programme noted an average improvement of 2 years and 3 months in the reading age (R.A.) of pupils (see table 4).
The greatest improvement in R.A. was 3 years and 4 months (Pupil C). Pupil G had the lowest recorded improvement and only kept pace with her chronological age. The project was later tried in fourth class and the average improvement in the reading age was 5 months. This progress was over a period of 6 weeks. The overall benefit of the project supports the view that multimedia has a very positive contribution to learning.

Very little research exists on the impact of ICT on students with disabilities. The Computers in Education project showed however that students with disabilities benefited greatly from ICT. The greatest gain for children with moderate mental handicap this study found was in the area of language development. Skills such as questioning and anticipation were also developed and project work of a high standard was accomplished. The use of peripheral devices, to compensate for the absence of motor control, was found to be particularly beneficial for children with physical handicaps. Non-articulating children and those with speech impediments were enabled to communicate more independently. Computers were found to aid, motivate and integrate into normal school life for such children. Visually impaired children also benefited as did children with profound learning impairments. (NITEC/DCU 1992:33). Pupils who suffered from profound hearing impairment also were successful in their use of computers in the classroom. Their motivation for learning was seen to increase significantly.

In Cahill’s study (1992) of access to mathematics and computer technology for 42 blind and partially blind students in Ireland and Belgium it was found that, while students’ learning processes benefited from the use of computer technology, the multimedia equipment available to them in some cases was insufficient and in other cases inadequate for their needs. For example this study found

‘that those who were integrated into mainstream schools had less access to computer modifications and adaptations than did their peers who attended special schools’ (Cahill, 1992:110).

This study also found that students and teachers overall were satisfied with word-processing packages and database software but were very dissatisfied with spreadsheet applications which were thought too difficult for people who were visually impaired. As a consequence of these deficiencies only a small proportion of blind and partially sighted students take the higher level maths examination. This survey suggests that this situation has more to do with mathematical access difficulties than with any conceptual or cognitive problem (ibid:113).
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Annex 8 - ICT in The Netherlands

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University of Nijmegen, The Netherlands

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1 The education system in The Netherlands

There is a rich variety of schools in The Netherlands, stimulated by the freedom of education which is part of the Constitution. There are public-authority schools, and there are Roman Catholic, Protestant, non-denominational, and Islamic schools. The latter four types of schools are run by private foundations, but are funded by the government. Within all categories (except Islamic schools) there are some schools that are based on specific educational orientations (like Montessori, Jenaplan, Freinet, Dalton, Rudolf Steiner). Diagram 1 gives an overview of the structure of the Dutch education system.

Diagram 1 - The educational system in The Netherlands (from: COMMITT, 1996)

At the age of 4, children enter primary school. Primary years 1-2 (ages 4-6) constitute the first stage of primary school. Around the age of 12 pupils enter secondary education, which consists of four school types: pre-vocational education (VBO), junior general secondary education (MAVO), senior general secondary education (HAVO), and pre-university education (VWO). Grades 1 to 3 of secondary education provide ‘basic secondary education’. In most schools there is a certain extent of heterogeneous grouping during the first grades of secondary education. From grade 3 on (in several schools from group 2 on) groups are homogeneous.
Pre-vocational education (VBO) and junior general secondary education (MAVO) provide the entry level for senior secondary vocational education (MBO) (at the age of about 16). Senior general secondary education (HAVO) prepares pupils for higher professional education (HBO) (which they may enter at the age of about 17), and pre-university education (VWO) prepares pupils for university (which they may enter around the age of 18).

Schooling is compulsory from the ages of 5 to 16. From the ages of 16 to 18, part time schooling is compulsory. There is primary and secondary special education for pupils with special educational needs and for pupils with disabilities. Special education aims at the ages of 3 to 20.

2 Policy with regard to ICT in education

In The Netherlands, two large scale projects were carried out in primary and secondary education respectively, in order to stimulate the implementation of ICT use.

In the second half of the eighties, all secondary schools in The Netherlands were equipped with nine MS/DOS computers in a local area network. The production of courseware was stimulated, and in-service teacher training was provided within the framework of this ‘Informatica-Stimuleringsplan’ (INSP) or ‘Information Technology Stimulation Plan’. Apart from this, several small scale projects were being funded. Several schools were appointed ‘pilot schools’. In these schools, the implementation of ICT was stimulated by extra funding and support, and the implementation process was monitored constantly by educational researchers.

In the first half of the nineties, the ‘Comenius-project’ was launched. The goal of this project was to equip all primary schools with (MS Windows) computers, at a rate of one computer at 60 pupils. Several software packages were included. Each school was obliged to appoint an ICT co-ordinator, and in-service training was compulsory for the school principal as well as the ICT co-ordinator in order for the school to be equipped with computers. The ICT co-ordinators were expected to act as ‘change agents’ within the schools, informing the teachers about ICT and stimulating them to incorporate ICT in their classrooms. The training of the teachers was primarily the responsibility of the computer co-ordinator. In addition, there was a national television course and support by local educational support institutions. In vocational training and in higher education, the use of information technology was being stimulated by government actions as well.
During the 1980s the government noticed the potential of multimedia in education. A steering committee was installed which was assigned to investigate the possibilities of multimedia. Several small scale projects were financed in which applications were developed and tested which made use of interactive videodisc, CD-ROM and/or telematics. When this steering committee ceased to exist, in 1991, the conclusion was drawn that multimedia may improve the connection between the school world and the outside world, and that these media may stimulate active and discovery oriented learning (Ministerie van Onderwijs en Wetenschappen, 1992). Nevertheless, the implementation of multimedia in education was not expected to take place in the near future, because of uncertainty about standards, high costs, and organizational problems. From that moment on, no specific policy with regard to multimedia in education was adopted. One of the conclusions from a quite recent study with regard to the implementation of ICT in education in The Netherlands (Moonen & Koomers, 1995), is that the situation concerning multimedia and telemedia during the mid 1990s was similar to the situation with regard to the implementation of computers in the early 1980s. According to the authors, the government was hesitating and was only taking a few incoherent measures in order to stimulate the use of these media. An advisory committee that was appointed by the Dutch Ministry of Education stated that the implementation of multimedia in schools calls for the same measures that were taken in order to stimulate the implementation of computers: supplying schools with hardware and courseware, providing teacher training and support (OCV, 1996). This committee noted that no fundamental changes were to be expected without proper actions taken by the government.

The general idea behind the Dutch government’s policy with regard to ICT is that the government provides the basic conditions, whereas the actual implementation of ICT into educational practice is being left to the schools. After providing the impulses noted, the government adopted the policy that implementing ICT in education was the responsibility of the schools, and that teacher training and courseware development would flourish without extra financial support by the government. This expectation, however, proved to be false. In 1994 it was concluded that technology was dominantly present in all sectors of society, whereas education was leaping behind (OCV, 1994). This was attributed to lacking knowledge of teachers, and to lacking or outdated infrastructures. There were doubts about the opportunities schools see with regard to the implementation of ICT in education. In 1996 again the conclusion was drawn that the use of computers in education in The Netherlands is stagnating (Magnee, 1996; OCV, 1996).
In 1997 the Ministry of Education launched a new plan, ‘Investeren in Voorsprong’ (‘Investing in Advancement’). Within the framework of this plan, schools were invited to make plans for incorporating ICT in education and to apply for the status of ‘advanced school’. Funding is available for plans that are approved. It is the government’s intention that all schools (primary education, secondary education, and senior secondary vocational education) will eventually reach the same (advanced) status with regard to the implementation of ICT. The government is aiming at a computer-pupil ratio of 1 at 10 at the start of the next century. Schools may acquire second hand computers from a foundation at low rates. Teacher training colleges are stimulated to incorporate ICT in pre-service teacher training and to provide tailored in-service training. The state of affairs with regard to ICT in the schools will be monitored during the years of 1997-2001. All schools are intended to benefit from the results that will be achieved in the ‘advanced schools’ (Ministerie van Onderwijs, Cultuur en Wetenschappen, 1997a, 1997b).

3 ICT use in education

3.1 Primary education

The results of the ‘Comenius-project’, in which the implementation of ICT in primary education was stimulated, were assessed by Van Zoelen et al. (1994). Main conclusions are that in nearly 90 percent of the schools surveyed computers were used in the classrooms (in grades 3, 5 and/or 7). On average, schools had six computers at their disposal. These were used mainly for mother tongue, arithmetic, and geography. Apart from this, in several schools computers were being used for drawing, traffic education, and environmental education. ICT was used mainly for doing exercises, for remediation, and for enrichment. The use of computers for discovery learning was almost nonexistent.

The study shows the ICT co-ordinator has quite some influence on the implementation of ICT. Teachers who judge the actions of the ICT co-ordinator more positively, are more likely to use computers during their classes, and are less likely to encounter problems during computer use. Another finding from this study is that as teachers are getting more experienced in using the computer they get a clearer view of the opportunities computers provide, and they gradually start using the computer more often. In many schools the impact of ICT use was unclear, although there was a significant improvement in 1994 as compared to the situation in 1989.
In nearly 90 percent of the schools the decision making process with regard to the way ICT will eventually be implemented in education had not been concluded at the moment the assessment was conducted. Main barriers to the implementation that were being put forward are:
- lack of computers;
- lack of suitable courseware;
- insufficient time for the development of lessons in which ICT use is integrated;
- insufficient financial support.

There was a need for more computers and more educational software in over 70 percent of the schools. Many school principals and ICT co-ordinators would like to have more insight in the quality of educational software. Many ICT co-ordinators would prefer to get support with regard to solving computer and software problems. The need for teacher training especially regarded teaching methods.

Janssen Reinen (1996) studied the degree of computer use by Dutch teachers in elementary education as well as factors that might explain why certain teachers use computers in their teaching practice to a greater extent than others. In the ‘early implementation model’ variables that are related directly to ‘intensity of computer use’ are ‘competence’; ‘attitude’; ‘teaching experience’ (more practice - less computer use) and ‘gender’ (male teachers use computers more than female teachers do). As the implementation of ICT proceeds, the value of this model appears to decrease. This leads to the conclusion that there is a changing model of factors influencing the intensity of computer use.

From the case studies that were conducted by Janssen Reinen, conclusions are drawn that communication is crucial for fostering ICT use, with the annotation that the mutual initiative for communication seems to be more important than the frequency of communication. It is agreed upon that the availability of computers in the classroom provides the best possibilities to integrate ICT in daily educational practice. One problem in this respect often mentioned is the lack of space in classrooms. Another conclusion from the case studies is that continued investments in infrastructures do not guarantee a growth in intensity of computer use. Another interesting result was that high intensity ICT users were more student centred, leaving the traditional context of whole class teaching.

Finally, the author states: ‘It seems that the so called ‘enterprising teacher’ reaches a certain level of integrating computers in daily educational practice. Characteristics of such a teacher are active involvement (initiative to start using the computer and to talk
about it), positive views on the educational impact and the possibilities of using the
computers and a different vision of the pedagogical structure of the teaching-learning
process. Other factors seem to be important for computer use as well, but do in itself not
provide a guarantee for high level computer use.’ (Janssen Reinen, 1996, p. 172).

3.2 Secondary education

A study of the implementation of ICT in secondary schools in The Netherlands by Ten
Brummelhuis (1993) shows that lack of educational software and lack of knowledge on
the teacher’s part constitute the main obstacles to the integration of ICT in secondary
schools. Other significant impediments are lack of hardware and lack of time. According
to Ten Brummelhuis (1995), who studied the factors influencing ICT use by teachers
during the adoption as well as during the implementation stage, the perceived relevance
of the innovation is the one factor which is significantly influencing ICT use by teachers
at both stages.

In an assessment of the Dutch government’s educational policy with regard to ICT (Ten
Brummelhuis, 1995), the conclusion is drawn that, in the early 1990s, an infrastructure
for information technology in secondary schools has been established (although this
infrastructure is relatively outdated); the subject ‘computer education’ has been
introduced; and a relatively small number of teachers use computers in other subjects
than ‘computer education’.

In a Dutch study with regard to agricultural education, insufficient availability of
software for instructional purposes was mentioned by 42 percent of the teachers
participating in the survey (Blom, 1997). Insufficient time to develop lessons in which
computers are used was mentioned by 59 percent of the teachers as a problem connected
with the use of computers. This study also showed that many teachers found it difficult
to integrate computer use in their present teaching strategies. The teachers’ lack of
knowledge and skills were mentioned as a barrier to ICT use by 38 percent of the
teachers surveyed. This study showed that a large group of teachers was eager to expand
their present knowledge about and skills with regard to the use of computers for teaching
and learning.

Veen (1994, 1995) concluded from his dissertation study that teacher factors outweigh
the school factors in explaining the teachers’ uses of computers. According to Veen,
teachers’ beliefs regarding what should be in the curricula and the way in which the
subject should be taught, play an important role in deciding whether or not to use ICT
in the classroom. Apart from this, teachers have beliefs about their roles in the classroom and about corresponding classroom activities, personal views on education and views on their own functioning as teachers. These beliefs influence their use of computers. The author states that teachers will adopt new media if they can use them in accordance with their existing beliefs and practice. The skills of teachers that most influenced their uses of computers were, according to Veen’s study, those skills related to their competence in classroom management activities, pedagogical skills and, less importantly, computer-handling technical skills (Veen, 1994, 1995).

A survey among ICT co-ordinators in secondary education (Renema & Smeets, 1992) showed that these people play an important role in the decision process with regard to the acquisition of courseware. Another important task of the ICT co-ordinator is to provide the teachers with information about courseware packages. Often teachers do not have sufficient information about the availability of courseware for their subjects (Timmer, 1991).

In a study of the use of multimedia in a Dutch secondary school (Smeets, 1996; Smeets & Mooij, 1996, 1997, 1999), four multimedia learning environments were implemented in geography education. In these learning environments interactive videodisc, CD-ROM and Videotex were used. Four different lesson sequences were developed and implemented in the education of pupils from the ages of thirteen to fifteen. While designing the four lesson sequences that were used in this ‘Pilot School New Media project’, a theoretical framework was used, consisting of four paradigms of learning and a model of information processing. The lesson sequences evolved from a very structured learning environment (‘instructive learning’) to an open-ended learning environment (‘discovery learning’). The latter has characteristics that are in accordance with the ideas of constructivism. These learning environments may be characterized as enriched learning environments. In the evaluation study, three levels were distinguished: 1) the pupil; 2) the teacher and the learning environment; and 3) the school. Questions to be answered, concerned the effects on the pupils’ amount of time on task and on the amount of pupil-pupil, and pupil-teacher interaction during the lessons, the learning gains acquired by the use of multimedia, the gains in pupils’ information handling skills, and the pupils’ opinions about learning in multimedia learning environments. Also, the impact on the teachers’ task and the way that is experienced, and the question whether the learning environments met the expectations, were assessed in the evaluation. Finally, the assessment had to provide information about the consequences at the school level and the extent to which the innovation was implemented in the school. The assessment consisted of various research techniques and activities: pupils’ questionnaires, learning gain tests, information handling skills gain tests, classroom observations, video registrations, and
The impact of information and communication technology on the teacher

Interviews with teachers, system operators, and school management. The nature of the study was comparative, with a design consisting of an experimental group and a control group. While the experimental group used multimedia in geography education, the control group was taught in the 'traditional' way. With regard to the teacher level, the following conclusions were drawn: The lesson preparation turned out to take substantially more time than teachers were used to, especially during the starting period of the project. The organization of and the activities conducted during the lessons differed considerably from 'traditional' geography lessons. Partly this may be due to different didactic procedures and ways of grouping pupils during working with multimedia. Apart from this, the teachers considered it to be more difficult during the experimental lessons to keep an overview of the learning progress the pupils made. The teachers felt that their role had become a less central one in the process of knowledge transfer. Nevertheless, their opinion was that their task had become more attractive by the implementation of multimedia in their classes. After the project was finished, the teachers kept on using the multimedia learning environments, although they made some alterations. Especially those elements with the strongest characteristics of enriched learning environments, were skipped or given more structure.

3.3 Differences between primary and secondary education

Although secondary schools in general have more ICT facilities than primary schools, there are several reasons why basic conditions for the implementation of ICT in Dutch primary education are better than in secondary education (see Lagerweij et al., 1992; Janssen Reinen, 1996):
- in primary education one teacher generally teaches all subject domains to a certain grade;
- in primary education there is more variety in teaching methods (e.g. groupwork, collaborative learning and investigatory activities);
- more than in secondary education, individual approaches of teaching and learning are found in elementary education;
- because of a later start of the government stimulation policy, most primary schools have more up to date equipment at their disposal than secondary schools;
- there is a difference in innovation policy at school level and school organization, referring to both the location of computers and the difficulties of organizing computer work in secondary education;
- the distance between educational support institutions and teachers is smaller in elementary education than in secondary education.
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Annex 9 - ICT in Spain

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Introduction

In preparing this report, I worked with different sources. However, no individual local or laboratory research has been used, but only general reports about the situation concerning the introduction of ICT in Spain, either in the whole territory or in specific regions. As it is explained in the report, government authorities developed programmes to introduce ICT with public funds, aimed at providing resources to public centres only. The most important of these programmes was the National programme (PNTIC, Programa Nacional de Tecnología Informática y Comunicativa), followed by the PIE (Programa d'Informàtica Educativa) in Catalonia. In Galicia the programme was put into practice in 1997. To get an idea, in 1996 the only person in charge of this programme used a private e-mail address to communicate via the Internet. In Valencia the situation was similar. In 1996 teachers in the CEP ('Centers of resources for Education') used their private e-mail addresses because there were no government programme based ICT activities available in the Internet. In Andalucia the situation was similar. At present, in Catalonia the PIE is offering an e-mail account and web space to every teacher in public centres in Primary and Secondary schools. This may serve to illustrate the vast differences that exist between different regions in Spain.

Private schools were not included in government programmes. Some schools' associations were founded as, for example, the Association of Christian Schools in Catalonia, but these remain marginal actions. In May 1997, at the '25 Congreso de la Enseñanza Privada' (25th congress on private education), organized by the 'Confederación Española de Centros de Enseñanza' (Spanish Confederation of Educational Centres), the introduction of ICT was one of the main topics, and in the course of the year 1997 it has been promoted in the private schools, basically by providing help with regard to software acquisition. During the preceding years, only individual centres or small groups had considered the introduction of ICT, but on a very small scale. In 1995, a large project was initiated to introduce ICT into private and public centres, with the support of public institutions and private companies, mainly with the support of Apple, and co-ordinated by the University of Barcelona: Grimm.

In 1990/91 an evaluation study was initiated by the National Programme PNTIC. This study was directed by Dr. Escudero, from the University of Murcia. The results of this study were published in the Conference 'Tecnología de la Información en la Educación: Una visión crítica' (Information technology in education: a critical vision) (Barcelona, November 1992). Meanwhile, this key information seems to be somewhat old and obsolete. There is no similar report for the PIE programme, neither for other public programmes nor private projects. I have therefore tried to locate the most recent
information on these programmes. The information I found seems to be more oriented towards showing the positive aspects than to describe the actual state of affairs. For this reason I have included this information directly translated from the original documents between quotation marks.

1 The educational system in Spain: an overview

The Spanish educational system - universities excluded - includes 7½ millions of students, with nearly half a million of professors in around 40,000 schools; 71 percent of these centres are public schools and 29 percent are private schools.

In Spain, the competences with regard to education are in the hands of autonomous regions (Comunidades Autónomas). Seven of the 17 regional authorities were given these competences in 1997 while the other 10 will assume them in 1998. These competences allow the regions to organize the educational system at primary and secondary level giving them the right to define educational contents (curricula), creating and closing educational centres, selecting teachers, etc. This is a key aspect to understand the process of ICT introduction in Spanish schools: there is not one single policy, but instead there are different regional governmental institutions with educational competences, which allow them to choose how they model education. However, there is a common core in the Educational system, Primary and Secondary levels, as we are going to explain immediately.

1.1 General Framework

The education process is organized at different levels:

<table>
<thead>
<tr>
<th>Stage</th>
<th>students' age</th>
<th>compulsory?</th>
<th>courses description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Childhood</td>
<td>3-5</td>
<td>no</td>
<td>P3, P4, P5</td>
</tr>
<tr>
<td>Primary</td>
<td>6-11</td>
<td>yes</td>
<td>Cycles 1 to 3, 2 courses by cycle</td>
</tr>
<tr>
<td>Secondary</td>
<td>12-16</td>
<td>yes</td>
<td>Cycles 1 to 2, 2 courses by cycle</td>
</tr>
<tr>
<td>High school</td>
<td>17-18</td>
<td>no</td>
<td>2 courses</td>
</tr>
</tbody>
</table>
1.2 Public and Private

Less than one third of schools are private schools. However, several of these centres have an agreement with the government that covers ordinary cost as teachers' salaries, assuring the access of students to these centres at a low fee.

Public centres

Public centres are run by a public institution such as the Ministry of Education or equivalent authorities in case of regions with educational competences, but they may also be local authorities. These differences do not affect to way they function with regard to teachers' salaries, selection of teachers, etc. but they do with respect to some key elements concerning the introduction of ICT, e.g. the maintenance of buildings and the distribution of special funds.

These differences have no correspondence with 'poor' and 'rich' localities. For example, frequently small villages with only one primary school 'take care' of it, in part because the sensibility of local authority and habitants, in part as a preventive measure to avoid that the educational authority moves the centre to a bigger city in a process of 'concentration' of schools. However, the socio-economic level of the neighbourhood where the centre is located is of importance with respect to the role of parents' associations that provide resources for the centres. It is necessary to remark that the motivation of parents determines the introduction of ICT to a large degree.

In public centres the director is elected, while in private centres this is more a professional than a political position. The lack of management training, the lack of effective management mechanisms and the lack of human-administrative resources have reduced the activities of the director to administrative and disciplinary functions (for instance, control that teachers have adequate accreditation, and that the school offers the official curriculum). These management deficiencies lead to corresponding deficiencies in the way ICT is introduced in the schools: there are no planning and no rational resource's management. Resources are distributed at will in line with the personal interests of some teachers. Consequently, one may find large differences between the ways teachers use ICT, and at the same time large methodological differences.

This lack of planning and the diversity between professors gives much liberty to the individual professors and may thus lead to a lack of continuous and homogeneous work for the time the students stay at the centre. For example, a professor might introduce
his/her students to search the Internet for information during one month, but, after this month, the students may never use the Internet for the rest of the year or even for the rest of their stay at this school.

**Private Centres**

There are two kinds of private centres: ‘Centros concertados’ and ‘Centros no concertados’.

‘Centros concertados’ are centres that periodically receive funds from the regional or national authority for regular expenses. In return these centres accept certain conditions with regard to the number of students, admission regulations, the maximum amount of money for admission fees, etc. These private centres are distinguished from public centres because they do not receive support in the form of hardware or software from the national or regional authorities. However, it is usual that parents provide some funds in order to acquire this equipment. As a result of this, the introduction of information and communication technology proceeds at a slower pace as compared to public centres. Moreover, if ICT is introduced, this is more because of commercial than for pedagogical reasons. On the other hand, these private centres have a more efficient management system, allowing for an introduction of technology in a more coherent and homogeneous way. Although the manager is elected in a similar way as in public centres, the tradition as well as the proprietary representative and the teachers’ selection process leave much power in hands of the owner, frequently church communities.

Finally, the ‘Centros no concertados’, which receive no funding by the government, work as companies, using the technology as a tool oriented as much to optimize resources as to attract new clients. They are usually elite centres and they have been acquiring a high quantity of resources during recent years.

**2 The government policy towards ICT in education**

Given the situation and the transfer of responsibilities it is necessary to make a distinction between ‘MEC territory’ - under the central authority - and the regions with competences in educational aspects. The MEC territory is under the control of the Ministry of Education and Culture and includes - as of 1998 - all parts of Spain with the exception of Euskadi, Catalunya, Galicia, Andalucia and Valencia. As it would occupy too much space, we are going to select only the most representative regions from the perspective of an advanced use of ICT.
2.1 MEC territory

The Ministry of Education and Culture (MEC) created two ICT stimulation programmes in Spain, one for the audiovisual media, formerly named 'Mercurio', and the other one for computers, named 'Atenea'. After some years both programmes converged in PNTIC, the National Programme for the Information and Communication Technology. This convergence reflects more the declining importance given to audiovisual media than a real integration of different media. The following text mirrors the analysis done by the PNTIC programme and the keypoints of its political actions. Quotations have been translated from the original Spanish text.

‘In the territory of direct management of the Ministry of Education and Culture, the activity in the field of Information Technology applied to educational environment outside universities is done through the Programme of New Technology of Information and Communication - PNTIC - that depends of the General Secretary of Education and Professional Education. This programme, created with the order of November 7, 1989, has a long and fertile trajectory in the design and materializing of educational projects using Information Technology’.

‘During this period 3,000 educational projects have been carried out, with the distribution of more than 25,000 computers, nearly 4,800 audiovisual devices - including videocameras, VCRs and editing consoles - and more than 30,000 professors have received training in the use of Information technology in the classroom. Every centre that participated in the project has at its disposal a modem, a CD-ROM player and a multimedia card’

‘Of the educational projects, 80 percent went to Secondary Education centres and 20 percent to Primary Education centres. It is necessary to note that schools have additional equipment provided by other sources, so some centres have an impressive amount of equipment at their disposal.’

Evidently, strong priority was given to centres in secondary education. These data apply to centres in the MEC territory; data on the other territories are not available. Data on private schools are not available either.

‘Similar interventions are developed through the equivalent programmes in the Education Departments in regions with autonomy in the educational field. The coordination (between regions and programmes) is assured through frequent contacts and periodic meetings that allow to exchange experiences and to synchronize the action guidelines.’
Although apparently the law of Moore [this is used by the author; I suppose that it refers to the statement that Gordon Moore made in 1965 which predicts that computer power doubles roughly every 18 months] plays with us, the budget effort has to be continuous because the investments in Information technology have a short life cycle and every year it is necessary to put an important part of resources aside for the replacement of hardware and software.

The text of the Ministry continues with a strong emphasis on three key aspects: the technology (hardware and software), the management of resources and the need of new funds. The text reflects the preoccupation with the distribution of equipment, training in the use of this equipment, and the change of strategy in the distribution of software. The predominance of technological over educational aspects may well be noted, as well as the Government’s mediating role with respect to the distribution of resources, and a centralization and administrative complication of actions.

Some characteristic decisions are the selection of an operating system for computers which was then made compulsory for schools - first MS-DOS and later Windows. It is obvious that arguments about compatibility are absurd because there is more compatibility between MacOS and Windows than between MS-DOS and Windows. In fact, the software that PNTIC is distributing at this moment is incompatible with most of the computers they have distributed until now.

The centralized style of PNTIC is similar to other regional programmes and it is reflected in the systematic rejection of any initiative that has not been generated or is not controlled by the PNTIC. Even the conception of the use of computers in education had to be adapted to the changing considerations of the PNTIC.

2.2 PIE - Programme of Computers in Education

A similar way of acting, but a more pretentious one can be found in the PIE programme in Catalunya. This programme also gives priority to secondary education. In 1996 computer rooms were available in every secondary public school centre in Catalunya, whereas these rooms were available in less than half of the primary schools. Although this is a personal estimation based on my knowledge of the situation and although I have no precise data to confirm, this assessment is shared even by the people from the PIE programme. The latest reductions in funds reduced also its power level and provoked the resignation of its director. At present, it continues with less resources but with the same style. The PIE is representative of regions with a high level of development.
The following text was elaborated directly by the PIE to describe its activity.

Established in 1986, the Programa d'Informàtica Educativa (PIE) is the agency of the regional government created with the aim of promoting and facilitating the full integration of information technology in teaching and learning activities at primary and secondary education levels. Since its beginning the PIE has been involved in:

- Equipping schools with microcomputers, peripherals and software.
- Providing computer maintenance and technical support.
- Promoting curriculum development, teacher training and offering educational support.
- Co-ordinating educational projects and assessing IT in schools.
- Establishing and operating information, documentation and telecommunication services.
- Fostering the development and dissemination of educational materials and IT-based projects.

From 1988 the Xarxa Telemàtica Educativa de Catalunya (XTEC) has offered the educational system access to communications, opening up new perspectives and enabling the possibility to carry out joint curricular activities. The educational activities offered by XTEC include:

- Access to information, resources and materials.
- A platform to carry out joint educational projects.
- Support to specific work groups.

It should be borne in mind that this programme only applies to public schools in Catalonia.

2.3 Valencia

Valencia constitutes a region with a lesser level of development. The programme for the introduction of Information Technology in Education is more recent. It was started in about 1995 with the following objectives:

1. To produce the guidelines for the use of computers at different levels of education outside the university.
2. To define the technical characteristics of hardware and software for the introduction and actualization of the New Technology at educational centres.
3. To co-ordinate and to participate in the Commission that decides on the purchase of computerized systems and to evaluate this equipment.
4. To propose the criteria for the distribution of resources in the educational centres.
5. To propose the criteria for the acceptance of new centres in the ‘Programa Informàtica a l’Ensenyament’.
6. To maintain a high level of documentation about this field with the participation in conferences, meetings, etc.
7. To propose the contents, and to organize courses for teacher education.

As may be noted, this programme reduces the objectives to distribute the hardware and to decide on courses for professors. As in other regional programmes, the control over the acquisition of hardware and software is a key aspect. The initiative of teachers is not only reduced in this aspect but also with respect to the training of teachers, to organizing centralized courses and to promoting seminars, meetings, and joint projects. Likewise, little emphasis is placed on stimulating ideas and actions that might come from the teachers.

2.4 Galicia

Galicia may be viewed as a representative of regions with a low level of development. A significant anecdote: while in Catalunya in 1996 each school could ask for an access to the Internet and each professor could apply for an e-mail account, in Galicia the only e-mail account and Internet access in public schools officially was in hands of the only person in charge of the introduction of technology in the schools in the whole region. And this was a private account, payed by himself!

At present the situation in Galicia is changing, but the delay with respect to Catalunya is quite noticeable.

3 The use of ICT in Primary and Secondary Education

These are some general characteristics of the use of ICT in Spain that we are going to address in the next lines.

3.1 Differences between regions

Due to the different levels of development as well as due to the various tasks assumed by the regional governments, there are large differences between Catalunya and other
regions. In Catalunya, since 1995 each secondary school centre has its own computer room. Since 1996 each professor at primary or secondary level in the public school system may ask for an e-mail account and for some web space. Each school has access to the Internet.

However, access to the Internet is provided by slow modems (14.4 or 28.8) instead of ISDN networks, and the teachers that asked for an e-mail account still constitute a minority - estimated between 10 and 25 percent - and most of them do not even use e-mail. In some cases, these e-mail accounts are being used by other relatives for private purposes. The computer rooms are in general equipped with 286, 386 and some 486 or Pentium processors which are too slow for Windows.

In other regions, the situation is worse. Usually each secondary school and most primary schools have computers, but in several cases this is only for use by the administration and by teachers, not for students. In some regions the number of students with access to computers in secondary and primary schools are very low.

3.2 Individual actions

Across the nation and especially in Catalunya, it is possible to find several very interesting phenomena such as virtual teachers conferences, international projects, introduction of computers in the first levels of schools, etc. However, these are frequently the results of individual actions, or there are only few professors involved in them. In the public school system, it is rare to find an action of the whole team of professors in this field. Students may therefore make very advanced experiences during one year to find that there is no continuation during the following ones.

3.3 Active professors

The introduction of computers has been more the result of the efforts of individual enterprising teachers than that of joint decisions and actions. But these actors of innovation have worked hard, and it is possible to find in different conferences and meetings numerous reports about their activities. These professors use to spend more time than required in the centre. They assume the task of training their colleagues as well as that of the technician to repair or to keep the computers running.
3.4 Fear of the computer

A lot of professors are afraid of computers: they are not sure about how to use them, and they also recognize that their students have a higher level of expertise in the use of computers. These teachers not only do not know how the computers work but they are insecure about the results of their actions. This feeling results into some kind of rejection of technological innovations. These teachers then tend to stress the value of human actions in the face of technology. They use to overestimate the books as a medium for learning. As far as this kind of rejection of computers is concerned, there seems to be little difference between public and private schools, while there seems to be less rejection in secondary schools, particularly with science teachers, as compared to primary schools.

3.5 Justifying the non-use of computers

Several professors try to justify their decision not to introduce computers in their classes by pointing out that the material available is poor, old and scarce. This is true in some aspects, but they might benefit from the high level of awareness concerning the use of technology that may be found in public and private institutions. In the public school system, teachers tend to wait until equipment is provided for, and they show no initiative in obtaining resources in other ways. This is changing, however, and a minority of teachers is very active and has managed to acquire a high level of equipment for their centres.

3.6 Methodological and cultural traditions

In secondary education in Spain, the professor is used to consider teaching in terms of giving lectures, with students taking notes. In this context, the use of computers is accepted as a specific course - about computers - but not as a tool to be introduced in one’s own class.

Activities such as research and collecting information are not part of the study habits of secondary Spanish students, and it is in this area where computers and networks might offer good solutions.

The following situation - albeit very strange - is not exceptional: the student has a computer at home: he/she is preparing his/her home work with the computer, using spelling facilities and correcting his/her text. Later, he/she will copy the text with a
typewriter ‘because the professor does not let him/her present the work done with the
computer’.

4. Some interesting experiences

If we cannot consider the situation from a global perspective, we may find several
interesting experiences at an individual, local, regional or even national level. From the
following URLs it is possible to access some of these projects:

el patinet
   http://www.vallesnet.org/pati/

grimm
   http://www.apple.es/educacion/proyectogrimm/Welcome.html

pntic
   http://www.pntic.mec.es/pntic/info/index.html

pie
   http://www.xtec.es/welcome/webang.htm
   http://www.xtec.es/welcome/pieang.htm (descripción)

NMai (Galicia)
   www.ceoug.org

Programa informática a l’ensenyament (Comunitat Valenciana)
   http://193.144.126.2:80/cdi/

Some additional information, including data about the Educational Spanish system may
be found at:
   http://www.mec.es/estadistica/Avance96/index.html

Part of this information was taken from Edutee, a Spanish list for Educational
Technology.