

# A variety of roles for a new type of teacher Educational technology and the teaching profession ☆

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## Abstract

This article focuses on the implications of the integration of computer technology into education for teachers, the teaching profession and the educational labor market. A Delphi study was done, consisting of interviews with experts in the field of educational technology and a round-table discussion of the results of the interviews. This resulted in two scenarios about the future of computer technology in education and its impact on teaching. In the first scenario educational technology primarily supports individualization of learning processes, in the second scenario the emphasis is on authentic learning in a community of learners, supported by technology. The article discusses these scenarios and their implications for the role of the teacher, the teaching profession and the educational labor market.

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## 1. Introduction

Schools throughout the western world have invested a lot in their ICT infrastructure over the past 20 years (Pelgrum & Anderson, 2001).<sup>1</sup> Students now use computers more often and for

a much larger range of applications. When computers were first introduced in the classroom the emphasis was on learning how to use ICT (learning about computers). Computers then became accepted as an efficient means of acquiring knowledge (learning from computers). Now ICT is primarily seen as one of the educational tools which can be used in the learning process (learning with computers) (de Corte, Verschaffel, & Lowyck, 1996).

Despite the growing number of computers used in schools and their increasing use, it cannot be said that revolutionary changes in schools have taken place under the influence of ICT. In The Netherlands, the National ICT survey, for example, shows that most primary-school students use a

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<sup>1</sup>A publication of the Dutch Ministry of Education, Culture & Science confirms this for the Netherlands. In two years (1998–2000), the ratio of computers per primary school student increased from 1:22 to 1:10, and in secondary education from 1:18 to 1:12 (Ministerie van OC&W [Ministry of Education, Culture & Science], 2001).

computer less than once a week and there are still many secondary-school teachers of a large number of subjects who do not use ICT at all (Van Gennip & Braam, 2002; Kools, Sontag, Hoogenberg, & Tolsma, 2002). The ICT applications that are used in most Dutch primary and secondary schools can be described, in Itzkan's (1994) terms, as 'substitution', that is to say, they take over some of the functions previously performed by other educational tools or the teacher. Drill-and-practice and instruction programs in a specific field, as well as word processing, are used the most. There are many other developments at the moment, however. The popularity of Internet and e-mail for educational purposes is accelerating, partly due to the fact that more and more schools have a connection with the Dutch education intranet (De Haan & Huysmans, 2002).

However, the stories about how ICT will change education go much further than this. Much has been written during the last 20 years about the changes the integration of computer technology into education will bring about. Recently, many seem to agree that educational technology will contribute to more 'constructivist learning', an increase in activity and greater responsibility on the part of students (Bransford, Brown, & Cocking, 1999). This implies far-reaching changes in the role of teachers. It is expected that teachers will support, advise and coach students, instead of merely transmitting knowledge to them, and will be able to adjust to their individual pace, interests and learning styles (e.g. Dwyer, Ringstaff, & Sandholtz, 1991; Bransford, Brown, & Cocking, 1999). In the Netherlands, however, the discussion on the integration of ICT is at the moment linked to another type of question concerning the teaching profession. Partly as a result of the rapidly growing shortage of teachers, it is increasingly put forward as a possible solution to the problems on the educational labor market and as a contributory factor to the professionalization and attractiveness of the teaching profession (e.g. de Boer, 2001).

This article reports on a study focusing on the implications of the integration of ICT into education for teachers, the teaching profession and

the educational labor market.<sup>2</sup> Examples of the kind of questions involved are: What direction could changes in the role of teachers possibly take? How will the integration of computer technology affect the attractiveness of teaching as a profession? Can computers help solve the teacher shortage? In this article first the methods used in the study will be explained: a Delphi-study consisting of interviews with experts in the field of educational technology and a round-table discussion of the results of the interviews. Then the results are presented. Firstly, some trends are sketched that all the respondents agreed can be expected in the near future. Different emphases were placed on these trends, however, and various interpretations were given to them in the interviews. For this reason, after a brief intermezzo, in the second part of the article two different scenarios will be discussed in which elements from these interviews are presented in such a way that they provide two contrasting views of the 'new role of the teacher'. Finally two topics concerning the labor market for teachers are discussed in more detail, namely the attractiveness of the profession and the shortage of teachers.

## 2. Method

The question how the integration of ICT into education will affect the teaching profession and the educational labor market was firstly approached by a brief review of the literature on computer technology, the teaching profession and the educational labor market. A limited literature search was done in ERIC and in Online Contents using the descriptors, computer/educational technology and teaching/teacher, and computer/educational technology and labor market. This search produced a lot of titles on changes in education influenced by the integration of ICT, but hardly any on issues concerning the educational labor market. We decided to select a number of key

<sup>2</sup>This article is based on research commissioned by the Sectorbestuur Onderwijsarbeidsmarkt (SBO—Sector Management Employment in Education), an advisory body of the Dutch Ministry of Education, Culture & Science.

publications on the first issue, and use anything we found on the second. The aim of the literature study was not to do a thorough review of the literature but to identify relevant themes for the interviews.

In the main part of the study a Delphi-like method was used. The Delphi method is a method commonly used by governments and businesses to make long-term projections in order to develop appropriate policy directions (Linstone & Turoff, 1975). It has many variations, but its main characteristic is the intention to reach consensus among a panel of experts through a series of rounds (iterations) in which panelists are asked to respond to a problem or give their forecast concerning a phenomenon. In between these rounds the experts receive information on the responses of the whole panel.

For our panel experts were selected who could be expected to be able to link a thorough knowledge of the teaching profession to a vision of computer technology in education in the future. Both the research team and representatives of the advisory body that commissioned the research proposed a first list of persons, who considering their publications, public statements, and/or position met this criterion. The idea was to include experts occupying a broad range of positions in educational practice, policy and science, in the study. The lists were compared and discussed and 10 respondents were selected, on whom agreement existed. When contacting the persons on the list, we asked for additional names for respondents for the study. When the same name was mentioned more than once, the name was included in a second list. Again a selection was made. All the respondents we approached agreed to participate in the study. Three experts appeared not to be available at the time of the interviews, but joined in the phase of the roundtable. Thirteen experts or stakeholders in the field of educational technology participated in the interviews: two school managers (primary and secondary education), two teacher educators (primary and secondary education), three educational scientists, two school advisors/consultants, an educational publisher, two policy makers, and an Inspector of education. In the roundtable additionally a consultant, a researcher and a secondary school manager participated.

Themes that should be dealt with in the interviews were identified on the basis of an analysis of the literature. Relevant themes for the interviews were identified by one of the researchers and validated in discussions with the two other researchers and representatives of the advisory body that commissioned the research, until a list of themes had been drawn up on the relevance of which consensus existed. These themes are:

- changes in the teaching profession influenced by ICT;
- changes in the organization of teachers' work (at a micro- and meso-level) under the influence of ICT;
- changes in the competences teachers need as a result of the increasing use of ICT;
- changes in the job structure;
- possibilities for differentiation and individualization;
- deskilling or upskilling of the profession;
- consequences for the attractiveness of the profession;
- possibilities of ICT in relation to the shortage of teachers;
- in each interview also suggestions for literature and names of experts who could be invited for an interview and/or the roundtable discussion were asked.

The analysis of the interviews was done in a number of steps.

1. Each of the interviews was transcribed and summarized in a report, which was given to the interviewee for his or her comments (member check), often accompanied by some additional questions from the researchers. A definitive individual report was made on the basis of the reactions of the interviewee.
2. The interviews were then analyzed by the research team.
  - a. A first round of analysis focused on the issues on which most interviewees agreed. Constant comparative analysis (Glaser & Strauss, 1968) was used to look for common themes (i.e. common expectations concerning future consequences of ICT for teaching) in the interviews. Each of the researchers

initially analyzed three interviews in order to identify such themes. These themes were then discussed among the researchers, resulting in a list of categories (learning processes, teaching materials, roles and competences of teachers, etc.) and expectations/opinions (e.g. students will increasingly work independently; the design of school buildings will change), and the interviews were coded according to these. When a forecast or opinion concerning the consequences of ICT was found in at least seven (more than half) of the interviews it was coded as a 'trend'.

- b. A second round of analysis tried to highlight differences between the interviewees. In this round we tried to construct 'scenarios': differing meaningful configurations of expected trends. The categories distinguished in the first round of analysis constituted the building blocks for each scenario. Now the focus was on different interpretations of trends within these categories, for example of terms like 'authenticity' or 'individualization'.
3. Each member of the panel then received a paper in which the responses and forecasts of all 13 interviewees were summarized and analyzed anonymously, in terms of trends and scenarios. Then a round table session was held in which the paper was discussed with the interviewees, and three more participants. The paper was slightly revised based on the discussion in this session, and an evaluation in terms of strengths and weaknesses of the two scenarios was added. All researchers and participants in the round table sessions approved of this second paper, so it was concluded that consensus had been reached. In our case this did not mean that the panelists agreed on the desirability of all of the future trends described in the paper, but that they agreed on the validity of the scenarios.

### 3. ICT in education from 2002 to 2020: general trends

In the first round of analysis of the interviews several general trends were found in the forecasts

and opinions of the panelists, concerning the consequences of the integration of ICT in education for teachers, the teaching profession and the educational labor market. Most interviewees expect changes in learning processes, teaching materials used, roles and competences of teachers and others in the school, school organization, and teacher training.

#### 3.1. *New learning*

All interviewees expect the traditional learning model (courses, linear teaching and teacher-centered instruction) to make way for a different style of teaching and learning, partly due to, but at least supported by, the influence of ICT. Students will increasingly work independently, possibly cooperatively, on assignments under supervision of the teacher. They will use a multitude of instructional formats, materials and resources. These can vary from a lecture or searching on the Internet to an individual counseling session or working on a group assignment via the computer. ICT also provides opportunities for more authentic learning. Real-life situations and phenomena can be simulated, for example, and students can carry out experiments themselves. Contact with the outside world is easy via e-mail. Many feel that the attention to authentic learning will result in more cross-curricular activities in the form of themes and projects. In this way ICT can contribute to making education more attractive to students. ICT facilitates, furthermore, more differentiation and individualization in education. It makes it possible to tailor the subject matter, both in terms of content and presentation, to the individual needs of students. Assessments, it is expected, will no longer be made by all students at the same time in the future. Students will be able to choose when they are ready to do a test. The way of testing may also change, with portfolios and digital tests, for example, being introduced. Many interviewees refer to 'constructivist teaching' when they mention these developments.

#### 3.2. *New teaching materials*

The Internet in particular will play a role in providing problems and assignments that are

constantly changing and being updated. Electronic learning environments offering course information, course documents and model tests, as well as facilitating a forum for communication between teachers and students, will become increasingly common.

### 3.3. *New roles and competences for teachers*

The teacher will become a supervisor of learning processes rather than a conveyor of knowledge but will also fulfill a broader range of roles. Tasks will become more varied and include instructing, coaching, training, advising and testing. Teachers will also have to learn to deal with the phenomenon that students are not all doing the same thing at the same time. This will require the acquisition of other skills by teachers. Subject matter and didactic knowledge is not enough; teachers must have supervisory and guidance skills as well. The ability to work in a team, to organize and to plan is important. It will become increasingly taken for granted that teachers have basic ICT skills. Much attention still needs to be paid to developing skills in the use of ICT in the classroom in the near future.

### 3.4. *New organization and facilities*

In general, teachers will work together more. There will be more teamwork, which will include other professionals as well as teachers. These teams will be responsible for the entire education of a group of students (numbering about the same as a few classes) or for a specific cluster of subjects to such a group. The range of possible ways of working outlined above means that the traditional timetable will disappear. The school building will also look different. It will have several large areas for lectures and presentations, areas for group work, and flexible work stations for students and teachers. Teachers and students will be able part of the time to work from home via an electronic learning environment. School information systems will play an important role both in the internal organization of the school and in learning processes. No school will be without a student

monitoring system, part of the school information system.

### 3.5. *Other positions*

The position of ICT coordinator, which now includes teaching responsibilities as well as technical responsibilities, will disappear. Groups of schools will organize their systems together or hire an external company to do this. In larger secondary schools, a technical department may be set up. Policy on the use of ICT will become a responsibility of the management team or of a teacher with additional ICT training. This teacher or management-team member will concentrate on questions like: What can you do with ICT? How can ICT contribute to differentiation? How can ICT play a role in the learning process of dyslexic children? The media resources officer will be an important position in every school. She/he will run the Open Learning Centre. Classroom assistants will continue to be employed in primary schools, freeing teachers to work at a higher level and hence be more professional.

### 3.6. *Initial training and in-service training*

Initial training and in-service training in the field of ICT will no longer focus on teachers being able to work with a large number of ICT applications, such as the (ECDL) european computer driving license or modifications of this for education. Both kinds of training will concentrate on the question of what learning processes can be stimulated by using ICT and by what kind of use. They will become more like training-on-the-job, with teacher participation playing a central role. This may be in the form of innovative projects involving student teachers. Teacher-training courses will offer more specializations in line with the tasks, positions and roles outlined above.

## 4. *Intermezzo*

The expected developments may prompt the suggestion that the integration of ICT into education will more or less automatically cause

changes in a particular direction. The influence of ICT is indeed often spoken of in this way (cf. the ‘true stories’ about educational computing which are analyzed by Bryson and de Castell (1994)). Several authors have since criticized this view. ICT is a collection of tools which can be used for different objectives in different ways. Or, as Niederhauser and Stoddart (2001) state (p.15): “Computer technology in and of itself does not embody a single pedagogical orientation. Different types of software can be used to address different educational goals.” Salomon and Perkins pointed out some years ago that the thinking on ICT in education should not be determined by what is technically possible but by which ICT applications can improve learning processes (Salomon & Perkins, 1996). The way in which ICT will influence education should be a question of pedagogical and educational choices.

On a more general level, the premise that there is no question of autonomous, unavoidable ‘consequences of ICT’ is also formulated from a sociology of technology perspective (e.g. Rachel & Woolgar, 1995). Firstly, sociologists of technology point out that the way in which technical artifacts, such as ICT, are used and the consequences thereof are partly determined by the form and design of the software itself, which in turn are based on human choices. Computer games, for example, were initially mainly modeled on games typically played by boys, which in turn alienated girls from using computers. Such choices, however, are often subconscious and, by the time a technological product has become commonplace, no longer visible. Sociology of technology analyses help us realize that design choices regarding the use of ICT in education are constantly being made at the present time. Assumptions about users and learning processes are ‘built into’ educational software. Such assumptions may pertain to the prior knowledge, learning approaches, interests and attitudes of students, or to the effectiveness of ways of structuring the curriculum or organizing student activities (De Vaney, 1998). It is this kind of choice that will predominantly determine how ICT will influence education, not ICT as an abstract phenomenon. Secondly, the design of a technological product

can never completely determine how that product will be used. This partly depends on how the technology is implemented in the user environment and on how (sometimes unexpectedly) the users work with it. Thinking along these lines, Niederhauser and Stoddart (2001) show that with regard to the integration of ICT into education, teachers tend to adopt technology in ways that are consistent with their personal perspectives on curriculum and instructional practice.

In this light the trends outlined above should be seen as trends which are not so much *determined* by the introduction of ICT but as trends which people think can be stimulated with the help of ICT. Many interviewees emphasized that what they would like to see stimulated and supported by ICT are innovations in teaching and learning inspired by a constructivist perspective.

In a second round of analysis a critical look was taken at the trends, formulated in the literature and in the interviews carried out for this study. This reveals that underneath the apparent consensus, there are actually different pedagogical ideals that people would like to promote through the integration of ICT. It appears that concepts such as ‘authenticity’ and ‘individualization’, although both being associated with the idea of ‘constructivist teaching’ can be interpreted differently.

The results of this analysis are presented in the next section, as two scenarios with different pedagogical accents and different options. Five of the interviewees can be associated more or less clearly with the first scenario. Three interviewees formulate elements that fit into the first scenario, but find elements that we mainly associate with the second scenario equally important. The remaining five respondents consider some elements of the first scenario useful in secondary education, but see the second scenario as their educational ideal, especially for primary education. Both scenarios deal with more or less the same topics: How will the learning processes of students change? How will the teaching materials develop? What will happen to the content and organization of the work of teachers? Will new jobs or positions emerge and how will these relate to one another? What competences does this demand of teachers and



other professionals in the school? In the next two sections these issues will be discussed for each of the scenarios, based on the summaries of the interviews. Quotes from the interviews will be included as illustrations of the visions presented. Each section concludes with an evaluation of the strong and weak points of the scenario under discussion.

## **5. Coaching individualized, self-directed learning in electronic environments**

### *5.1. Learning processes*

Individualization of learning processes is central to this scenario. The teacher is primarily the organizer of different forms of learning for individual students. Forms of differentiation go much further than they do now. It will become possible to adapt objectives, content, sequence, teaching method and format of presentation to the preferences and characteristics of the person (Koper, 2000, p. 18). Students mostly work self-directedly on assignments in a study room or open learning center. Working at home is also possible. In addition, students can follow short lessons taught in classes, as well as signing up for small-scale workshops, when they want to learn more about a particular part or aspect of the subject matter. Placement-like elements can also be included in students' study program. The use of multimedia applications for instruction makes education more 'lifelike' and exciting.

Students 'learn to learn' by being given more and more responsibility for their own learning process: planning, monitoring and evaluation. Teachers coach students in different ways: in small groups, one-to-one, by e-mail or in video conference-like settings, etc. Assessment is predominantly digital. Students themselves indicate when they are ready to take a test on a particular part of the subject matter. There is a test bank from which students themselves download their tests. The test bank is linked to a monitoring system making it easy for teachers to follow the progress and development of individual students.

I am a proponent of self-testing. ICT can be used very well for self-testing; students can get their own tests from a test bank, and repeat a test several times, if necessary, for example until they master 80% of the subject matter, or 90% or 100%, depending of which goal a student has set for herself (Teacher educator secondary education).

### *5.2. ICT teaching materials*

In this scenario, ICT is not only used to present the subject matter tailor made for the individual tempo, level or learning style of students, but also to make processing it more interesting for students. Electronic learning environments are used where students cannot only find course information but also lessons, assignments with answers, and tests. The electronic environment gives access to different instruction and drill-and-practice programs. Multimedia instruction programs make education more 'lifelike' and exciting. Educational simulation programs can bring complex or dangerous processes in the real world right into the school.

Working self-directedly when and where you want to (for example, at home) is made easier by the fact that students and teachers have a laptop linked to the school via mobile network technology. Ideally students have access 24 h a day to the subject matter, both at home and at school, so that they can study at any time they want. E-mail is the means of contact between students and teachers.

The digital teaching materials, developed by professionals, do have a degree of flexibility. Thus it is possible for the teacher to change the examples, assignments, background information, the sources etc.

The materials must be flexible. Teachers only tend to approve teaching materials when they have 'played around' with them. This should be taken into account in the design. (Professor of education).

### *5.3. Teachers' roles and competences*

Teachers are expected to know a great deal about individual learning processes and to have

the skills to coach those processes, as well as subject knowledge. Electronic learning environments are rational systems which take a lot of work off teachers' shoulders. The role of teachers, however, will become more complex rather than simpler. Teachers must know what programs are available that are suitable for their students' individual needs and keep abreast of this. They are the 'arrangers' of students' learning processes: they bring together the educational tools and set them up in a particular way. In addition, they fulfill the role of instructor, trainer, coach, advisor, consultant and assessor.

I see five new roles for teachers: 1. instructor; 2. consultant, to whom a student can go with questions and information on assignments and tasks; 3. trainer, who supports the training of specific skills; 4. navigator, who is the coach in the whole learning process; 5. assessor, who assesses the progress of the student (Teacher educator secondary education).

Huge demands are made on teachers' ability to plan in fulfilling all these different roles for different students. They have more freedom and flexibility in their work on the one hand, yet on the other, the necessity of keeping the information in the student monitoring system up to date, adds an administrative element to their work. This requires a more structural approach which in turn limits their freedom.

#### *5.4. Organization and facilities*

In this scenario, the educational process can in principle be independent of time and place. It is a mixture of distance learning, learning in the classroom and out of school, which is often called 'distributed education' (Jochems, 2000, p. 76). It is no longer necessary to organize students in classrooms with regular teachers:

In secondary education we will have 'distributed education', a mix of learning in a classroom environment, learning outside the school, in businesses and other organizations, distance learning. This makes differentiation possible;

teaching can be adapted to the level of the student (Professor of education).

Students work in groups of changing composition in areas for self-directed learning where a number of teachers are present. The school building will look very different than it is does now; as well as the study areas with individual workplaces there will be lecture halls, project-group rooms, consultation rooms and flexible work stations for teachers. Computers are all over the school, not just in the computer rooms:

The school will have a number of large physical rooms, in which at least three teachers are working with students on certain learning domains. A student enters such a room and starts working self-directedly, with a laptop or without, all wireless. Everything the teachers offer to the student, that is instruction, assignments, examples, pre-tests, is on the internet. All students have a smart card, which registers, for example, attendance and logging in at home, and arranges registration for lessons and tests. They may also be working at home, which the teacher knows through the smart card system (School manager secondary education).

The school remains a meeting place for students. Social activities are organized and facilities are provided, making it worthwhile to come to school:

The canteen becomes a pleasant café and the gym can be used for sports of the students' own choice. The school is open from 8.30 a.m. until 5.00 p.m., and after that the internet café is open until 8.00 p.m. (Policy maker).

Teachers work together in teams comprising teachers for a particular cluster of subjects (arts, science, social sciences) or teachers who are responsible for a specific group of students. Together they decide what teaching materials and/or software should be purchased and there is close consultation on students' progress. Teachers' time is divided into parts of the day rather than hours. How these parts of the day are spent, for example teaching, supervising in the study areas or administering tests, is agreed at school level or



within the team. This creates all kinds of possibilities for greater flexibility which is in fact an improvement in the secondary conditions of employment for teachers. ICT plays a supportive role in communication within the team about the individual development of the students for whom the team is responsible and in the far more complex organization of education.

### 5.5. *Positions*

A teacher does not necessarily have to be able to fulfill all these roles. More differentiation will be made between tasks and positions:

Not all teachers will have the same skills and that will not be necessary. Some are better instructors, others are better at coaching. Teachers will be able to specialize in a particular role and opt to work only as a trainer or as a coach for a period of time. Ultimately the term ‘teacher’ will disappear (Inspector of education).

Supportive roles will also develop in and around the classroom. Examples include classroom assistants (who may have a specific task in the field of ICT), assistant teachers for special-needs teaching (using ICT), computer room manager/supervisor, media resources officer, applications manager and webmaster.

### 5.6. *Evaluation of the individualization scenario*

The individualization scenario outlined here has a number of strong points. Teachers have a great deal of insight into and a grasp on the development of individual students, which is also an advantage for students. This approach gives them a clear idea of what is expected of them: what am I ultimately supposed to have learned and what progress am I making? The diverse ways of working, the variety of teaching materials and ‘distributed learning’ make learning more varied and attractive to students.

There are also a number of risks to this scenario. Firstly, care must be taken that a balance is maintained between the professionalism encompassed in electronic teaching materials and the

professionalism of the teacher. It may be tempting in this scenario to work with complex software which analyzes where students get stuck in their thinking process, when previously this was typically a task of the teacher in direct interaction with the student. The risk of deprofessionalizing the teaching profession was not considered realistic in the interviews. Yet it is not totally hypothetical when we look at the arguments for education that is less ‘teacher dependent’, given that the teacher is the ‘weakest link in education’ (de Boer, 2001). The literature certainly also talks about the risk of ‘deskilling’ of the teaching profession as a consequence of the introduction of ICT. Apple and Jungck (1998), for example, place this risk in the broader context of increasing differentiation between the design and implementation of learning processes.

A second risk is that ‘cognitive learning’ is in danger of becoming separated from ‘social learning’. Fitting in with students’ individual needs is mainly fulfilled in this scenario by presenting the subject matter in a tailor-made way to individual students; this can result in the pedagogical function of schools receiving insufficient attention. This is a problem because students will miss essential learning experiences in the social and moral field. It is also a problem because young people need to feel that they belong, that they are part of something, to be able to develop their own identity. The school as a ‘meeting place’ will probably not offer enough support for this.

Elements of this scenario are mainly, but not exclusively, found in the forecasts and opinions of panelists whose work is related to secondary education.

## 6. **Supporting learning communities with technological tools**

### 6.1. *Learning processes*

The group as a learning community is central to this scenario. A teacher or a team of teachers supports and inspires a group of students working together on authentic problems. In this way an attempt is made to make learning more in tune

with the world in which children and young people live. Different forms of ICT are employed here. Internet is an important source of information but students do not only virtually go out of the school, they also literally do so. Although there are educational objectives to be attained, there is not a set amount of material which the students have to cover. Students look for the answers to questions that often cross subject boundaries. In fact, they are supposed to learn ‘productively’. They build up knowledge and acquire skills in this process. Specific skills (writing, math, reading, but also arguing and reasoning, or using scientific formulae) are practiced during the process but only when this contributes to solving the problem. Education becomes more lifelike as the questions that students are dealing with are ‘real’ problems:

It is crucial to make education more attractive to students. There is a huge motivation problem. Experiments are going on with projects, practice-oriented and thematic assignments. ICT is able to play a supporting role in such developments (Inspector of education).

Working in small groups, students are not all doing the same thing. For example, one student might research a particular subject and share and discuss the information she/he has found with others (see also the jigsaw method, [Brown & Campione, 1994](#)). Students follow their own learning path.

In this scenario, students also work independently a lot of the time albeit often in the context of a group assignment. But the class/group fulfils a crucial role—it functions as a learning community or community of inquiry ([Wells, 1999](#)), each student making her/his own contribution. The formulation of questions, planning, sources to be used, hypotheses, results, progress, the group process etc. are regularly discussed by the whole group:

We have language students prepare a multimedia presentation of a poem in their second year. This is done in groups of three. The students are also involved in the evaluation of each other’s work. We use criteria such as: are connections made with similar poems, is the

navigation system clear and easy? In particular we ask students to explain the choices they made in the design process (Teacher educator secondary education).

The role of the teacher is dependent on the level of the group and is one of steering and guiding. This ‘instruction’ is in the form of introducing new themes. Sometimes this role is fulfilled by others, for example, other teachers or parents or visitors from elsewhere who have more expertise in the field in question. ICT also plays an important role here; an example is the Jasper series, in which real-life problems are introduced with the help of a video ([Cognition and Technology Group at Vanderbilt, 1992](#)).

‘Learning to learn’ as a learning objective does not only involve being able to guide and plan one’s own learning processes but also to acquire a critical, investigative approach. It means that students learn to ask questions, acquire the skills necessary to find answers to these questions, and interpret their answers.

Students do not take many tests. Assessment is based on the portfolios (that are partly electronic) prepared by students. They must show what knowledge they have constructed and skills they have acquired. Presentations are also important. These are put on the Internet. Students are involved in assessing each others’ work:

We started working with portfolio’s, as schools themselves suggested that they needed a way to track the experiences of the children and to follow their development. The portfolio is mainly digital. What they do digitally is part of it as a matter of course, but sports events, dance, drama, etc., can be included also through video or photos (School consultant primary education).

## 6.2. *ICT teaching materials*

ICT is used in this scenario in the first instance to create learning environments in which students can actively work on solving ‘real’ problems in daily life (e.g. interactive video environments and simulation programs). Computer applications are also useful in visualizing abstract concepts such as

force and movement, complex mathematical functions or genetic concepts. Learning environments that support cooperation and mutual feedback play an important role (e.g. computer-supported collaborative learning, CSCL). (Scardamalia & Bereiter, 1994) ICT is also used as a production medium. At the end of a project, students produce a multimedia presentation on cd-rom or a website, which is sometimes commissioned by a company, museum or other external organization.

Lastly, ICT is used to facilitate and improve connections between the school and the outside world. Libraries, museums and companies are visited via the Internet. E-mail is used to communicate with people and organizations outside the school and with students in other schools (see also Bransford, Brown, & Cocking, 1999). Working with instructional and drill-and-practice programs only has a modest place in this scenario. Panelists associated with this scenario are therefore critical about much of the available software:

Test results for basic knowledge and skills are used to assess teachers in the current system. Educational software for primary education is designed according to this principle: mainly programs for exercising basic skills in a small domain (School manager primary education).

The programs used are produced in close cooperation with teachers and students. Educational publishers are responsible for the digital teaching material. A well functioning school information system is essential; the development and progress of individual students is recorded by a student monitoring system which not only includes test data but also data taken from observations made by the teacher. Moreover, this monitoring system is linked to students' electronic portfolios.

### 6.3. *The roles and competences of teachers*

The teacher in this scenario is a tutor who facilitates the learning process of the group and the individual students, employing all her/his creativity. Pedagogical knowledge and skills and subject knowledge in a broad field are expected of teachers. They become 'educational designers',

preparing not lessons but projects. This makes planning and coordination skills important. These projects cross the customary boundaries between disciplines and subjects which necessitates intensive cooperation between teachers. Consultation with colleagues from the same and other schools is important in preparing and implementing projects. Subject specializations and specific teaching skills are utilized in implementing particular methods of working. The roles of instructor, trainer, coach, etc., are important in this scenario too:

I see a teacher as an allround professional, who knows a lot about different domains, but in particular is able to provide support to individual and collective learning processes. In the learning process he or she does not function exclusively as an instructor, but also, and maybe more so as a coach, a source of information. Thus the tasks and roles of teacher become more varied (Researcher).

In addition teachers are adept at prompting and holding discussions with students about meaningful questions. Internet plays an important role in communication between teachers. Ideas are presented and discussed. In this way teachers have access to the ideas and materials of others, a source of inspiration for lessons and projects:

On the national educational Intranet teachers can share and discuss ideas. This is a new way of professionalisation (Educational advisor).

### 6.4. *Organization and facilities*

Secondary-school teachers may work in a team that is responsible for a number of classes. This team also includes other professionals such as teaching assistants and media-resource-center assistants.

It is possible in this scenario to learn regardless of time and place but the provision of facilities for this does not have a high priority. The school building houses a social community and symbolizes the social and integrative function of the school. The layout and organization of the building, however, has changed. Study rooms, a lecture hall, project-group areas, etc. also feature

in this scenario. The school has more contact with the local neighborhood—with companies, museums and other institutions—as well as cooperation with, for example, youth-work organizations. Parents and other local residents are more closely involved in the school and the school is more strongly embedded in the community. This ‘community school’ also has a virtual form; parents can follow, for example, a course via the school’s intranet. The school itself is open all day and has a café, run by students, which is also open for part of the evening:

The school will have much more relations with the world outside of the school. The concept will be that of ‘the school in the neighborhood, the society’. Schools will cooperate with youth care, and parents will be able to log in on the school network, and follow a course. We will have ‘community schools’, also virtually (Educational advisor).

#### 6.5. *Positions*

The roles of instructor, trainer, coach, etc., are not separate positions in this scenario. Specializations are possible though: educational-tools management and educational-tools design. There are also support staff, like classroom assistant and assistant teacher. Other personnel are also required to ensure the smooth running of the media resources center, to supervise the reading room, etc. The teacher remains, however, the backbone of the whole process, holding ultimate responsibility. Some positions are fulfilled by the students themselves. They are trained, for example, to help younger students.

#### 6.6. *Evaluation of the learning communities scenario*

The strongest point of this scenario is that it makes learning meaningful for students. They do not learn in order to pass a test or an exam but because they are working on questions to which they want to know the answer, because they want to do something well, and because they feel responsible for the group process. This scenario

also offers many opportunities to realize the ‘moral task’ of the school. Education is not just aimed at acquiring abstract knowledge; students also reflect on the social and personal meaning of that knowledge. In addition, developing social competence is a learning objective that goes without saying. Lastly, in this scenario teachers really are educational designers. Using their subject and pedagogical expertise, they themselves develop a powerful learning environment geared to their own students. This makes demands on both teachers’ creativity and their subject knowledge.

There are also weak sides to this scenario. It makes heavy demands on teachers’ professionalism. The available data on students’ development are, for example, more subjective. When there is inadequate supervision (the teacher does not observe students’ development properly or does not draw the right conclusions about their development), students can fall by the wayside. Teachers also play a bigger role in developing teaching materials. Many teachers develop material in the form of projects and assignments which they make available to others. This material is not screened and is of varying quality. Teachers can also lose track of what material is available.

Elements of this scenario are mainly found in the interviews with panelists, whose work is associated with primary education.

### 7. **ICT and the educational labor market**

Two ways in which the integration of ICT into education may develop in the near future have been outlined above. The emphasis was on the changing role of students, teachers and teaching materials and the consequences of these changes for the organization of work. Two themes were discussed in connection with the educational labor market, namely ‘skills required by teachers’ and ‘new positions’. This section will pay specific attention to two typical labor market themes, the attractiveness of teaching as a profession and the shortage of teachers, on which we also asked questions in the interviews and which were discussed in the round-table session. Differences

between the two scenarios described above will be pointed out where possible.

The ICT-related developments in education that are expected over the next 20 years embrace a number of aspects that can make teaching as a profession more attractive. ICT can play a role in enhancing the profession. Coaching students in their learning processes with the help of various technological tools and other support staff can result in a far-reaching professionalization of teaching. In any case, the tasks of the teacher will become more varied. Depending on how the supporting technological systems are structured, the developments described above do offer teachers more flexibility and freedom:

By employing personnel with lower educational qualifications, who can assist students who work at the computer, it will become possible for teachers to work at a higher level. This will make them feel more like professionals. Likewise school managers get their hands free, when they are supported by an office manager and a school-porter for example (Policy maker).

The possibility of developing and adapting teaching materials does not make teachers' work easier but does make it more interesting. This also applies to designing powerful learning environments in a broader context. The second scenario in particular does encompass elements which can promote the 'attractiveness' of teaching in this sense.

In both scenarios, the change in the division of tasks between student and teacher means that teachers will be less involved with disciplining students, leaving them free to concentrate on the essence of their work, stimulating students' development:

ICT mainly supports a teacher in boring and routine tasks. A 'frequently asked questions' section on a website for example, makes it possible to restrict the time spent at explaining the same thing again and again. Correction work can be minimized in favor of the real, challenging work of coaching students (Manager secondary education).

Teachers who derive their professional identity from transferring information to students may find their work less attractive as a result of these developments. In the first scenario in particular, teachers may begin to feel like 'administrators' owing to the perpetual necessity of recording whether students have kept to their planning. Care must be taken here that the ideal of the electronic environment does not degenerate into a means of delivering a 'canned' or pre-packaged curriculum over which the teacher has little or no control, as described by Apple and Jungck (1998). Nevertheless, panelists do not expect a deprofessionalization of the teaching profession in this scenario:

An impoverishment of the profession of teacher will not easily occur. It is their professionalism to stay informed about all courseware packages. They must know which kind of ICT is best used when and where. They must know how to adjust the teaching methods when a student gets stuck. Moreover, teachers can specialize in a certain area (for example internet or coaching) and share their expertise with the team. Potentially the teaching profession can become richer (Inspector).

Teachers now get a chance to get in charge of the learning process, to develop content, and to be informed in a much easier way about what a colleague 300 or 3000 kilometers further on is doing. This does not mean things are getting easier for teachers, but things are definitely getting more interesting (Policy maker).

The development of new specializations and even new positions can also make the profession more attractive to teachers. In this way, a career perspective can develop and this can contribute to preventing burn-out. A teacher can, for example, concentrate on coaching and guiding students for a few years and then switch to a position in which the focus is on designing teaching materials. This does make new demands on human-resources policy, as attention will have to be paid to the rotation of tasks. This in turn requires more flexibility in the terms and conditions of employment.

The question whether a greater emphasis on ICT in education or perhaps an ICT specialization in teacher-training courses will appeal to a different group of people, or to more or to less students than the present students training to become primary or secondary-school teachers, is difficult to answer. A greater emphasis on ICT in teacher training can on the one hand have negative implications for female students in particular (Volman & van Eck, 2001). On the other hand, the use of ICT will be something that future generations of boys *and* girls increasingly take for granted. Students will already have more ICT skills when they start their training:

There is no opposition between an increased role of ICT and working with children in education. Working with children remains the core of the job. The difference is that it is done with modern tools. The appeal of the teaching profession will never be caused by the role of ICT, it is appealing because a teacher works with people in an interesting way (Policy maker).

Adequate ICT facilities in schools and the provision of such facilities at home can make a positive contribution to making teachers' work more attractive, while the opposite, the lack of such facilities, contributes to the image of a 'poverty-stricken sector'. Working in good, modern conditions with opportunities for training and working with new media contributes to the image of a modern profession:

Education has an image of a shabby sector. Teachers should work in adequate, modern environments. Let us please stop deciding for them what they should do in these environments, that is part of being a modern professional. The image of a job that is not pared down, where you get chances for further training, in which you work with modern media, will make the profession more attractive; that is the appeal of a modern profession (Policy maker).

Working with both children and ICT does not have to be a source of conflict. Depending on how ICT is employed in education, it can make

working with children more interesting, for example, by making it possible to give students more individual attention:

ICT can help to better take into account differences in individual learning styles and learning possibilities of students. For most teachers the core of their job is to be involved in promoting the development of children. ICT can be used to skip all kinds of boring tasks, to diminish correction work, to get information easily. ICT does not cause less emotional involvement in the children's work at all (Teacher educator primary education).

Personally I think teaching has become more interesting because of ICT; it has become more varied, more complex. I used to be occupied all day with what the students were not allowed to do. Everything was focused on what the teacher did, the interesting information he or she could give. Now there is much more interest in students' development, in the interesting things they can do, make or think. Then they appear to be able to do much more than you had expected (Teacher educator secondary education).

The question of what changes will ICT cause in teachers' day-to-day work is particularly important here. In their analysis of the construction of the teacher/computer relationship in educational advertising, Selwyn, Dawes, and Mercer (2001) identify a disempowering portrayal of the teacher at the expense of the computer. They argue that this demotion of the teacher is likely to have negative effects on the way that teachers approach ICT as part of their professional routine. But the consequences of such images might be even worse: they may contribute to an unattractive image of the teaching profession.

Lastly, many expect ICT to contribute to solving the shortage of teachers. A Dutch commission with the objective of exploring long-term solutions to the problems in the labor market in the collective sector paid a great deal of attention to ICT. One of the essays on which the recommendations of the commission are based, described, for example, the following vision of the future. "A light, spacious but not too large,



friendly school. The greater part (about two-thirds) of the teaching materials for the cognitive subjects will be offered on the computer under the supervision of tutors. The number of teachers in the school will be reduced by about a third.” (de Boer, 2001, p. 11.) There was general agreement in the interviews and the round-table discussion that teachers cannot simply be replaced by computers. The idea that students who work independently can manage with fewer teachers was also challenged:

The learning process in itself can be organized more efficiently, this will mean an improvement of quality. But it is not possible to do it cheaper or with less people (Policy maker).

What is expected is a shift in the tasks of teachers, which on the one hand involves the professionalization of the teaching profession and, on the other, the creation of positions (requiring varying levels of qualifications) to support the work of teachers. Staff for these positions could be sought in other parts of the labor market.

## 8. Conclusion

This article has explored future developments under the influence of ICT in the teaching profession. It is based on a literature survey, interviews with experts and a round-table discussion. To conclude, I will sum up the most important findings, make some suggestions and formulate a few points for discussion.

A number of general trends were described in this article concerning the way in which people think that ICT will change education. Many of these trends in fact reflect educational ideals that have been around for some time—authentic and meaningful learning, independent and cooperative learning, cross-curricular and project-based learning, fitting in with the individual needs of students—which have regained popularity in recent years under the influence of (social) constructivist learning theories (e.g. Bransford, Brown, & Cocking, 1999). People hope that ICT will help realize the new forms of learning they envision.

Two scenarios were then described on how the integration of ICT may change education. The literature does indicate that behaviorist and constructivist theoretical orientations give rise to fundamentally different conceptions of the use of computers in instruction (Niederhauser & Stoddart, 2001). Our scenarios, however, are both consistent with a constructivist approach to teaching and learning, and neither can be dismissed as traditional or can be reproached a substitution-like use of ICT. In the first scenario, teachers ‘arrange’ the learning processes of students: they collect teaching materials (in secondary schools, in a specific subject field) and use them in a way which is suitable for individual students. An additional administrative element to teachers’ work, which is very important, is keeping the student monitoring system up to date. An extensive knowledge of individual learning processes and the skills to supervise these processes are the main components of teachers’ professionalism. Teachers fulfill a wide spectrum of roles: instructor, trainer, coach, advisor, consultant and assessor. But a teacher does not necessarily have to be able to fulfill all these roles. More differentiation will be made between tasks and positions. In the second scenario, the teacher is primarily a tutor who creates the conditions for the learning process of the group and of the individual students, and who coaches and guides them during the learning process by making suggestions, challenging them and helping them to reflect. Teachers prepare projects, not lessons, projects that cross the boundaries of individual disciplines. Roles like instructor, trainer, coach, etc., are not separate positions in this scenario. A teacher fulfills all these roles in relation to a student. There may be specializations, however: subject specializations and specializations in teaching method.

These scenarios are compositions, in which elements from the literature and interviews are organized into two sharply contrasting views of the future. The one does not completely exclude the other; elements from both were often evident in the interviews. Contrasting these two views of the future can help clarify where and when choices may arise from the perspective

of ‘new roles and positions for teachers’. One of the most important points made in this article was the importance of reflecting on the choices yet to be made in relation to ‘the influence of ICT on education’, and of not letting these choices merely be determined by the technological possibilities. The integration of ICT must support an educational concept that has been consciously chosen.

No differentiation is made in the scenarios between educational sectors and types of school. These differences did sometimes come up in the interviews. Almost everyone considered the group to be essential in primary education in connection with the role that the school can play in the social development of children (see scenario 2), while in secondary education the emphasis is on working self-directedly (scenario 1).

Many different views on how the integration of ICT into education can make the teaching profession more or less attractive emerge from the literature and the interviews. Some point out that the profession of teacher will be ‘richer’, more professional and more varied but that the developments make huge demands on the subject knowledge and creativity of teachers. At the same time, others warn that there will be a shift from subject expertise to administration for the teacher, a shift that fits in with a tendency towards centralization and standardization of teaching, whereby control is taken away from the teacher.

Regarding the shortage of teachers, nobody ultimately agrees with the ‘simple’ solution of computers replacing teachers or with the idea that students learning self-directedly can manage with fewer teachers. Both scenarios certainly involve a shift in the tasks of the teacher, involving a professionalization of teaching on the one hand and the creation of positions requiring a lower level of qualification to support teachers on the other. Staff for these positions could be recruited from other sectors of the labour market. The place of ICT and the opportunities it provides in new occupational structures in the teaching profession is one of the most important points to be considered from the perspective of the educational labour market.

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