New technologies, new differences.
Gender and ethnic differences in pupils' use of ICT in primary and secondary education

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Abstract

This paper investigates the accessibility and attractiveness of different types of ICT applications in education for girls and boys and for pupils from families with an ethnic minority background and from the majority population in the Netherlands. A study was conducted in seven schools (primary and secondary). Data were collected on participation, ICT skills and learning results, ICT attitudes and the learning approach of pupils. A total of 213 pupils completed a questionnaire and interviews were held with 48 pupils and 12 teachers. Gender differences, especially in primary education, appeared to be small. In secondary education, the computer attitude of girls seems to be less positive than that of boys, girls and boys take on different tasks when working together on the computer and they tackle ICT tasks differently. Pupils from an ethnic-minority background in both primary and secondary education appear to consider themselves to be less skilled ICT users than pupils from the majority population. We found ethnic differences in participation in ICT activities at school in both educational sectors. Pupils from an ethnic-minority background use the computer at school less for gathering information and preparing talks and papers and more for drill and practice. Differences between pupils from an ethnic-minority background and from the majority population in access to certain forms of ICT use out of school are confirmed at school instead of being compensated for. The paper concludes with some recommendations on a diversity-oriented ICT policy at school level.
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1. Introduction

In recent years, ICT has rapidly acquired a place in society. Without doubt, this is also true of education. After the initial emphasis on learning *about* ICT, it is now increasingly used as a *learning tool* in all forms and all levels of education. The question is whether this development has the same meaning and consequences for all pupils. Pupils differ in their experience of and attitude toward ICT. At home they do not all have the same access to ICT and they use the ICT resources available at home differently. In this way, differences in ICT knowledge and skills develop between pupils. Against this background, the increasing role of ICT as a learning tool could cause problems for pupils who have less experience of technology or have less affinity with ICT. Earlier research shows that girls and pupils from an ethnic-minority background are two groups who require special attention in this respect. Differences between pupils with different social-economic backgrounds are also mentioned in this respect but scarcely any research has been done on this (Sutton, 1991; Volman & Van Eck, 2001).

Most research in this field by far is on gender differences. It is an established fact that there are gender differences in ICT use both at home and at school, regardless of the availability and access to ICT resources (Janssen Reinen & Plomp, 1997). Research also shows persistent gender differences in computer attitudes (e.g., Comber, Colley, Hargreaves, & Dorn, 1997; Durndell & Thomson, 1997). Concern about ethnic differences and ICT use at school is mainly based on surveys indicating that computers are unevenly distributed among different groups of the population (Novak & Hoffman, 1998). Very little is known, however, about ethnic differences in knowledge, skills and attitudes in the literature.

It has become clear in recent years that observations about differences between groups of pupils regarding ICT should differentiate between the types of ICT application (e.g., Kay, 1992). Girls answer general questions about ICT attitude, for example, less positively than boys but are enthusiastic about applications like word processing and drawing (Volman & Van Eck, 2001). Such nuances, however, are not made in the large-scale surveys which are frequently the source of information on differences between pupils in computer use, skills and attitude. This was the reason for setting up an exploratory empirical study on how attractive and accessible the use of different types of ICT applications at school are for different groups of pupils. The results of this research should provide schools with input for developing a diversity-oriented ICT policy. [1]

Four basic differences between pupils can be found in the literature on the use of ICT in education: differences in pupils' participation in ICT activities at home and at school, in both knowledge about ICT and knowledge that is the result of learning with ICT, in pupils' attitudes, and in their approach to working with ICT. We therefore formulated the following research questions:

- to what extent do gender differences and ethnic differences exist in *participation* in using ICT applications?
- to what extent do gender differences and ethnic differences exist in *ICT skills* and *learning outcomes* of pupils using ICT applications?
- to what extent do gender differences and ethnic differences exist in the *attitude* of pupils towards ICT applications?

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[1] The research was commissioned by the ICT Directorate of the Dutch Ministry of Education, Culture & Science.

- to what extent do gender differences and ethnic differences exist in the *approach* of pupils in their use of ICT applications?

Below we will first describe the study that was set up to answer these questions and then present the results. We conclude with a discussion on the guidelines resulting from this research on a diversity-oriented ICT policy in schools.

2. Method

The research questions were answered with the help of a literature study and empirical research in seven Dutch schools (four primary and three secondary schools). We collected data on the participation, skills and learning outcomes, attitudes and approaches of pupils working with certain ICT applications. Six promising ICT applications used by relatively a lot of schools were selected for this purpose. Our aim in the primary schools was variation in level (intermediate level and upper years, respectively) and variation in the nature of the applications. The following applications were chosen:

- The *Ambrasoft* software package, a 'drill-and-practice' program which pupils use individually for spelling and sums (intermediate and upper years).
- the *Jouw Toekomst in Amsterdam [Your Future in Amsterdam]* e-mail project. Pupils from two primary schools e-mail each other about what their lives will be like in 2020. The learning objectives of the project relate to both ICT and language. It is designed for the upper years of primary education.
- *Ontdeknet [Discovery Net]*, a program for gathering information on a topic that interests pupils by communicating with adult 'experts', for example, people with an interesting profession, hobby, travel story or social involvement (upper years).

The criterion for selecting the applications for secondary education was that several years (lower and upper years) and subjects (arts, humanities and sciences) were represented. The following applications were selected:

- *The Image of the Other*, a program used in modern-language lessons in the lower years of secondary education.
- The *Global Teenager* e-mail project in which pupils in the lower years communicate in English with pupils from other countries about a social topic.
- *IP Coach*, a program for the natural sciences and operating technology with extensive possibilities for measuring and analysing, for model operation and video measurement, predominantly aimed at pupils in the upper years of secondary education.

As schools and classes can vary in the way they use ICT programs in practice (Schofield, 1995), each application was studied in the context of two different classes in different schools. Our aim was to include pupils from an ethnic-minority background and pupils from the majority population in the research group for each application, as we wanted to be able to investigate ethnic differences. We succeeded in forming a research group of four primary and three secondary schools that fulfilled these criteria. (In two of the primary schools only one application was studied.) A number of points should be made here. Firstly, diversity in the pupil population in the primary schools was realized by predominantly white schools and predominantly black schools participating in the research. (The percentage of pupils from an ethnic-minority background in

'white' schools and from the majority population in 'black schools' was always less than 25%, respectively.) No truly mixed primary schools participated in the research. Two of the secondary schools were predominantly white and one was mixed (40% from an ethnic-minority background, 60% from the majority population). Secondly, the secondary-school pupils participating in the research were following general-education courses. This is particularly important in interpreting ethnic differences. After primary school, the majority of pupils from an ethnic-minority background in the Netherlands follow pre-vocational education, a lower qualification than general-secondary education. Thus pupils from an ethnic-minority background participating in this research constitute a specific group.

At each school the pupils from the classes using the applications in the research completed a questionnaire. The variables participation, ICT skills, learning outcomes, attitude and approach were operationalized for the application in question. These pupils were also asked more generally about their use of ICT (at home and at school), about aspects of their ICT attitude, and their approach and skills in working with other applications. For the general (i.e., not application-specific) part of the questionnaire on computer use, computer skills and attitudes, items from the questionnaire developed for the Dutch ICT monitor study were used, so that comparison with national data would be possible (Gennip & van Braam, 2002 (primary education); Kools, Sontag, Hoogenberg, & Tolsma, 2002 (secondary education)). The reports on this monitor study do not mention scales having been constructed, all data are reported at item level. We will also report our data at item level. The items on ways of working with ICT were constructed as operationalizations of concepts appearing in the literature. The questionnaires for primary and secondary education were similar but not identical. Table 1 shows the distribution of the respondents to the questionnaire.

The ethnic minority pupils in our sample were mainly coming from Moroccan, Turkish and Surinamese lower-SES families, with at least one parent not being born in the Netherlands.

The results of the questionnaire were analysed with ANOVAs. For testing differences between mean scores T-tests were used. We have also compared the answers to some of the questions with

Table 1
Overview of respondents

	Ethnic minority[a]	Majority population	Total
Primary, boys	18	37	55
Primary, girls	26	38	64
Primary, total	44	75	119
Secondary, boys	8	38	38
Secondary, girls	7	49	56
Secondary, total	15	79	94

[a] Pupils were classified in the study as coming from an ethnic minority background following the criteria used by the Dutch Ministry of Education: an ethnic minority pupil is a pupil with one of the following characteristics:
• belongs to the Moluccan population;
• at least one of the parents born in Greece, Italy, (former) Yugoslavia, the Cape Verde Islands, Morocco, Portugal, Spain, Tunisia or Turkey;
• at least one of the parents born in Surinam, Aruba or the Dutch Antilles;
• at least one of the parents admitted to the Netherlands as a refugee;
• at least one of the parents born in another non-English speaking country outside of Europe, except Indonesia.

data from the national ICT education monitor 2000–2001 (Gennip & van Braam, 2002; Kools et al., 2002) as a means of ascertaining the extent to which our research group differs from Dutch primary and secondary-school pupils as a whole. The primary-school pupils in our research had a somewhat higher mean score for some skills (e-mail and using the Internet) and somewhat lower for others (word processing and laying out a text) than the pupils in the national sample. There was no structural difference in the level of skills. The secondary-school pupils participating in our research clearly scored higher in the average number of hours of computer use at school. This is possibly related to the fact that the schools in our research were schools for general and pre-academic education, while vocational-education pupils also completed the ICT-monitor questionnaires. The secondary-school pupils in our research judged themselves to be about the same level as the participants in the ICT education monitor regarding computer skills.

In addition to the questionnaire, interviews were held with two pairs of pupils in each class (48 pupils in total). Teachers were asked to select two girls and two boys with average ability levels, in such a way that pupils from the majority population or from an ethnic minority background were always both represented. The interviews concentrated on the way in which pupils had worked with the application, their approach in working with the application and their experiences when working with it. The teachers of the classes that participated in the study were also interviewed, focusing on the way in which the application had been used in the class and the teacher's perception of differences between pupils in working with the application (12 teachers in total). Prior to the school visits, the ICT applications selected were analysed in terms of gender inclusiveness and/or cultural sensitivity (see, e.g., Biraihmah, 1993; Bradshaw, Clegg, & Trayhurn, 1995). A checklist was developed on the basis of the literature study for these analyses (see www.kennis-net.nl/sp/diversiteit). Special attention was paid in the interviews to aspects of the applications that stood out in terms of gender inclusiveness or culture sensitivity arising in the analyses. These analyses were also used in interpreting the data on pupils.

3. Results

In this paper, we will not discuss the results of the individual schools and the specific applications but will look at the results as a whole from the perspective of gender differences and ethnic differences in the use of ICT in primary and secondary education. The findings on differences in participation, ICT skills and learning outcomes, attitudes, and pupils' approach will be discussed. The results from the general part of the questionnaire will in each case be discussed first. We will then analyse the results regarding the specific applications, which are based on both the questionnaire and the interviews. The findings will be related to the literature on the topic in question. We will start with a short summary of the analysis of the applications.

3.1. Accessibility and attractiveness of the applications

The ICT applications in our study vary greatly in nature and objective, content and design and instructional structure. The analysis of the applications in primary education produced very few indications that the applications were less attractive to certain groups of pupils. It was possible for pupils of different gender and ethnic background to identify with all the applications. The 'Your

Future in Amsterdam' e-mail program is extremely open with room for the ideas and experiences of all participants. The drill-and-practice program Ambrasoft includes illustrations of both Dutch and ethnic minority children. Although Discovery Net is an interesting and attractive application, it was the most limited in this respect as no experts from a non-Dutch background participated in the program. In the interviews with pupils, it was apparent that some of the pupils from an ethnic-minority background noticed whether children/people from such a background featured in a program and that they considered this to be important. The level of language skills required in Discovery Net (long, difficult reading passages) was a problem for some pupils from an ethnic-minority background in particular.

There were clear similarities between the nature and objective of the Image and Global Teenager applications in secondary education. Both programs mainly make demands on the language and communicative skills of pupils. Global Teenager is aimed more at working together. Although the analyses of the applications do not suggest they are less attractive to certain groups of pupils, the high demands made on language and communicative skills were found to appeal to girls especially. The Coach program is a science-oriented program with a wide range of possibilities. It requires more different skills. This proved to encourage pupils (see below) to choose gender-specific tasks. Girls concentrate more on report writing and less on 'experimenting scientifically', thus placing more emphasis on language skills. Opportunities for pupils of different gender and ethnic background to identify in the form of illustrations and story line did not play a major role in the applications studied.

3.2. Participation

3.2.1. ICT use out of school

Numerous studies show that girls work with ICT at home less than boys. This is not only the case in the Netherlands and the United States but also, for example, in Germany (Bannert & Arbinger, 1996), Sweden and Japan (Makrakis & Sawada, 1996) and Yugoslavia (Kadijevich, 2000). In recent years, research in this field has shown more nuances. Gender differences, for example, are not apparent in every ICT application (De Haan & Huysmans, 2002), and are less common in younger pupils than in older pupils (Volman & Van Eck, 2001). Ethnic differences in ICT use are also apparent in the literature. Black pupils in the USA were found to have less access to ICT and the Internet and appear to find alternative ways of using the Internet less readily than white pupils (Novak & Hoffman, 1998). Recent Dutch research shows that differences between families from an ethnic-minority background and from the majority population in computer ownership and Internet connection are decreasing (De Haan & Huysmans, 2002).

No significant gender differences were evident among the primary-school pupils in our research group. Boys and girls spend their time out of school fairly evenly on the ICT activities specified, varying from playing games to word processing, drawing and Internetting. In secondary education, boys spend more time programming and playing computer games than girls. Although not as many primary-school pupils from an ethnic-minority background have access to a computer at home as pupils from the majority population, on average they spend as much time using the computer per week, as reported by the pupils themselves. The explanation given for this by teachers at the schools participating in the research was that pupils who do not have a computer or access to the Internet at home make good use of the computers in the public library. Pupils

from an ethnic-minority background and from the majority population do use computers out of school hours, however, for different purposes: the former use the computer to learn words, do sums and study topography more often and the latter to e-mail and Internet. Using the Internet more often is indicative of the easier access to a computer with an Internet connection. At secondary level there is scarcely any difference in computer ownership between pupils from an ethnic-minority background and from the majority population but there are differences in how the computer is used at home. Pupils from an ethnic-minority background work less on papers and presentations, and write less letters, reports and e-mails out of school than pupils from the majority population.

3.2.2. Computer use at school

Various studies show that girls use ICT less than boys not only at home but also at school, and when they do, they use it differently (e.g., Janssen Reinen & Plomp, 1997). The same nuances have been made as those regarding computer use at home: gender differences are not the same for every ICT application and are not as great in younger pupils (Rocheleau, 1995; Comber et al., 1997; Durndell & Thomson, 1997). Research in the 1980s and 1990s found that pupils from lower social classes and from ethnic-minority groups in the USA were exposed to other forms of ICT use than white and *middle-class* pupils (Olson & Krendl, 1990; Sutton, 1991). This was found to be mainly a matter of differences in school policy. More recent research on pupils' use of technology also reveals differences in use by school socio-economic status (SES). A national study by Becker (2000) documented that pupils in low-income areas often use computers for repetitive activities, whereas pupils in high-income areas frequently use technology for higher-order thinking, problem solving, and other intellectually challenging activities.

Table 2 shows the different ICT applications the pupils from our research group worked with at school and the gender and ethnic differences we identified. In all the tables, the average scores of primary-school and secondary-school pupils are given and significant gender and ethnic differences are pointed out. The percentages of pupils from the different groups who worked with an application, as reported by the pupils themselves, are given in the text below.

There are no differences between boys and girls at primary school in the extent to which they participate in the computer activities named. In secondary education girls do e-mail at school more often than boys, while boys play computer games more often than girls.

Our data indicate that pupils from an ethnic-minority background and from the majority population encounter different ICT applications at school. It was evident that pupils from an ethnic-minority background use the computer less often for gathering information for preparing a talk or a paper and for writing a paper in primary education. They also surf the Internet less at school. Pupils from an ethnic-minority background use the computer more for practising skills but the difference is not significant. As in primary education, secondary-school pupils from an ethnic-minority background use the computer less for gathering information for papers and preparing talks. They also use the computer less for writing reports and more for practising skills. This last finding is probably due to the fact that drill-and-practice programs are given high priority in schools with many pupils from disadvantaged groups. It confirms the differences in ICT policy, depending on the pupil population, which have been identified in the USA.

Gender differences appeared to be small in ICT use in general but also in the use of specific applications at school. Girls and boys made equal use of the six programs and projects studied in

Table 2
Type of computer use at school, primary and secondary, differences between pupils[a]

Computer use at school/ primary and secondary	% Pupils in primary education who have used the computer for...	Gender differences in primary education, % female/male pupils		Ethnic differences in primary education, % minority and majority population pupils		% Pupils in secondary education who have used the computer for...	Gender differences in secondary education, % female/male pupils		Ethnic differences in secondary education, % minority and majority population pupils	
		F	M	Minority	Majority		F	M	Minority	Majority
Learning words, sums or topography (primary)/practising skills (secondary)	53	55	51	48	56	44	41	47	**67**	**39**
Drawing (primary)/ working with pictures or photos (secondary)	19	22	15	20	17	27	27	26	20	28
Gathering information for a talk or paper	56	55	58	**18**	**56**	69	73	63	**27**	**77**
Preparing a talk (primary)	12	12	11	7	15					
Giving a talk or presentation (secondary)						53	55	50	40	56
Writing a letter or story (primary)/report (secondary)	50	50	49	50	49	53	54	53	**27**	**58**
Writing a paper	35	33	36	**23**	**41**	29	27	32	13	32
Doing an experiment, e.g., in physics (secondary)						17	14	21	7	19
Writing and reading e-mail messages	57	59	55	50	49	49	**59**	**34**	47	49
Surfing on the Internet	63	59	67	**39**	**75**	67	68	66	60	68
Chatting	11	11	13	11	12	35	37	32	33	35
Building a website	5	5	5	9	3	12	11	13	7	13
Programming	3	5	0	5	1	2	2	3	7	1
Playing computer games	33	30	36	39	29	13	**7**	**21**	7	14
Other activities	6	9	2	7	5	13	14	11	20	11

[a] The questionnaires for primary and secondary education were not identical. When the questions were approximately the same, we have presented the data in one table and in separate tables when they differed considerably. Significant differences ($p < 0.05$) are indicated by highlighting the scores in the tables.

more detail in both primary and secondary education, according to the questionnaires they completed. There are also no differences in participation between pupils from an ethnic-minority background and from the majority population. This means that the differences found in the use pupils reported of ICT at school are probably differences between schools rather than differences between groups of pupils in schools.

3.3. ICT knowledge and skills and learning outcomes of working with ICT

The literature points out that differences between pupils in knowledge and skills in the field of ICT, as well as differences in knowledge and skills in other subject areas, can be linked to the use of ICT as a learning tool. We will look at both issues in more detail below.

3.3.1. ICT skills

The literature indicates that girls score less well than boys in tests that measure ICT knowledge and skills (Janssen Reinen & Plomp, 1997). Little is known about ethnic differences. Our research showed some differences in ICT skills, as reported by pupils themselves (see Tables 3 and 4). Girls

Table 3
Command of computer skills (as reported by pupils themselves), primary education, and differences between groups

Skills, primary	% Pupils who have a command of the skill	Gender differences		Ethnic differences	
		% Girls	% Boys	% Minority	% Majority
Starting the computer	98.3	98	98	100	97
Starting a computer game	90.8	89	93	86	93
Playing a computer game	94.1	92	96	93	95
Writing a text on the computer	91.6	92	91	80	99
Saving a text	87.4	84	91	**77**	**93**
Bold print	81.5	78	85	**66**	**91**
Moving sentences around in a story	72.3	69	76	**57**	**81**
Entering letters with accents (e.g., ë, é, è) and punctuation marks	48.7	45	53	39	55
Using the spell check	62.2	56	69	**48**	**71**
Inserting an existing picture in a story	62.2	56	69	**45**	**72**
Drawing a square and a circle on the computer	78.2	80	76	**66**	**85**
Changing the colour of the letters	87.4	86	89	**77**	**93**
Turning an illustration upside down	37.8	34	42	**25**	**45**
Sending an e-mail	81.5	77	87	**68**	**89**
Answering an e-mail	79.8	77	84	73	84
Forwarding an e-mail	68.9	66	73	59	75
Sending a file (attachment) with an e-mail	42.9	39	47	36	47
Surfing the Internet	88.2	**81**	**96**	**73**	**97**
Printing an Internet page	77.3	78	76	**61**	**87**
Bookmarks/favourites	31.1	30	33	**16**	**40**
Using search engines on the Internet	67.2	64	71	**48**	**79**
Downloading a file from the Internet	54.6	**45**	**65**	**34**	**67**
Chatting	64.7	64	65	61	67
Building a website	33.6	30	38	32	35

Table 4
Command of computer skills, secondary education, and differences between groups

Skills, secondary	% Pupils who have a command of the skill	Gender differences		Ethnic differences	
		% Girls	% Boys	% Minority	% Majority
Using MS-Windows	85.1	82	89	**67**	**89**
Using a word-processing program	92.6	93	92	87	94
Using a database program	69.1	63	79	67	70
Using a spreadsheet program	72.3	71	74	53	76
Drawing graphs	76.6	75	79	67	78
Drawing	92.6	91	95	87	94
Using a presentation program	70.2	70	71	**20**	**80**
Sending an e-mail	88.3	89	87	**73**	**91**
Answering an e-mail	90.4	91	89	80	92
Forwarding an e-mail	87.2	89	84	**60**	**92**
Sending a file (attachment) with an e-mail	80.9	79	84	**60**	**85**
Surfing on the Internet	89.4	89	89	80	91
Using search engines on the Internet	92.6	91	95	93	92
Printing an Internet page	91.5	93	89	93	91
Downloading a file from the Internet	86.2	**80**	**95**	80	87
Bookmarks/favourites	75.5	70	84	**53**	**80**
Building a website	51.1	45	61	47	52
Chatting	89.4	89	89	80	91
Burning a CD	60.6	50	76	40	65

at primary school consider themselves to be less good at surfing and downloading files from the Internet. Less girls than boys at secondary school said that they could burn a CD and download files from the Internet.

Far more differences were shown to exist between pupils from an ethnic-minority background and pupils from the majority population (see Tables 3 and 4). Primary-school pupils from an ethnic-minority background consider themselves to be less competent than pupils from the majority population in 15 of the 24 skills. This particularly applied to word-processing skills (e.g., moving sentences in a text), working with illustrations (e.g., inserting an existing picture into a story), and skills involved in using the Internet (e.g., using search engines). Fewer secondary-school pupils from an ethnic-minority background consider themselves to have the following skills than pupils from the majority population: use MS-Windows, use a presentation program, e-mail skills, and bookmarking favourites.

3.3.2. Learning outcomes of working with ICT

There are indications that girls achieve less well than boys in computer tasks (Barbieri & Light, 1992). In relation to pupils from disadvantaged groups and pupils with a low level of achievement, ICT is seen in particular as a means of helping them to improve their achievements, as their specific needs and level can be better accommodated with ICT. We did not find any concrete findings on this, either in the literature or in our research. With regard to the secondary-school applications in our research, teachers did find differences between girls and boys and between

pupils from an ethnic-minority background and pupils from the majority population. According to these teachers, these differences result in different learning outcomes, particularly differences in understanding of the subject matter (see also under approach).

3.4. Attitude

That girls have a less positive computer attitude than boys is acknowledged worldwide (e.g., Huber & Schofield, 1998; Makrakis & Sawada, 1996; Volman, 1997). The differences are not so great in younger pupils (Comber et al., 1997; Durndell, Glissov, & Siann, 1995). Differences in attitude between boys and girls are most common in the aspects 'confidence in working with ICT' and 'plans to work with ICT in the future'. We did not find any literature on ethnic differences in attitude towards ICT.

The pupils in our research were generally positive about computers. Tables 5 and 6 show how the opinions of girls and boys and pupils from an ethnic-minority background and pupils from the majority population differ.

One in three primary-school pupils expect better job prospects in the future if they can work with computers. There are differences between the different groups of pupils on this point. Girls do not have this expectation as often boys, and pupils from an ethnic-minority background have higher expectations of computer expertise in terms of a future job than pupils from the majority population. Here, we found no other gender differences in computer attitude but pupils from an ethnic-minority background and pupils from the majority population do differ in a number of

Table 5

Attitudes towards computers in primary education and differences between groups

Attitudes, primary	% Agree	Gender differences		Ethnic differences	
		% Girls	% Boy	% Minority	% Majority
I like talking about computers with others	61.5	58	65	65	59
My parents encourage me to use computers	16.7	18	15	**30**	**9**
Computers can help me to learn things more easily	70.9	63	80	**88**	**61**
I know that I can learn a lot from computers	85.5	83	89	86	85
You can do lots of things with computers	89.1	89	89	**80**	**95**
My parents want me to be good at using computers	54.4	48	62	61	50
You benefit a lot from being able to use computers well	90.8	91	91	86	93
All children should learn to use computers at school	78.6	77	80	86	74
I want to know a lot about computers	67.0	60	75	73	63
Computers do not interest me very much	19.0	23	15	14	22
I like lessons in which computers are used	85.6	91	80	84	87
If you can use computers, you will get a better job in the future	36.3	**26**	**48**	**53**	**26**
I have to ask the teacher if I can use the computer	93.2	94	93	89	96
I want to use the computer at school more often	68.1	71	65	**96**	**62**

Table 6
Attitudes towards computers in secondary education and differences between groups

Attitudes, secondary	% Agree	Gender differences		Ethnic differences	
		% Girls	% Boys	% Minority	% Majority
I know more about computers than the teacher	29.5	**17**	**49**	29	30
I use computer at home for more difficult things than at school	62.2	56	72	50	64
My parents know nothing about computers	36.0	30	46	57	32
I need help at school when using the computer	8.0	9	6	7	8
I like looking up things on the Internet	93.2	92	94	92	93
My parents encourage me to use computers	48.9	52	44	36	51
I want to know a lot about computers	50.6	**30**	**83**	**79**	**45**
Computers do not interest me very much	23.3	**33**	**8**	14	25
Computers help me to learn things more easily	59.6	54	69	57	60
I find it difficult to look something up on the Internet	5.6	6	6		7
I like lessons in which computers are used	86.4	**80**	**97**	86	86
The computer explains things better than the teacher	29.5	31	26	29	30
I want to use the computer at school more often	74.4	70	81	86	72
The computer does not always do what I want it to	27.0	**17**	**42**	21	28

respects. In comparison to the latter, pupils from an ethnic-minority background feel they have more support from their parents with regard to using computers, they experience more help from the computer as a learning tool, and would like computers to be used more at school than pupils from the majority population do. Pupils from the majority population emphasize more than pupils from an ethnic-minority background that you can do all sorts of things with computers. That pupils from an ethnic-minority background think more positively about the use of ICT at school than pupils from the majority population may be due to the fact that they have less opportunity at home to use a computer. Parents' encouragement may also play a role here.

In secondary education, there are differences in the attitude of girls and boys regarding computers on a number of points. Boys say more often than girls that they know more about computers than their teacher. Boys also want to know more about computers and are more interested in them. They say more often than girls that they like lessons in which computers are used and experience more control of the computer than girls. With regard to these statements, we found only one difference between secondary-school pupils from an ethnic-minority background and pupils from the majority population: pupils from an ethnic-minority background want to know more about computers more often than pupils from the majority population. Moreover, the differences already discussed regarding the skills pupils report they have can also be interpreted as a difference in attitude, namely a difference in confidence in their own ICT skills. In secondary schools, this confidence is lower in girls than in boys and in both primary and secondary-school pupils from an ethnic-minority background than in pupils from the majority population.

Girls liked some of the specific applications included in the research better than boys. Communication-oriented applications in both primary and secondary education fall into this category. There is only one marked gender difference, however: girls assessed the 'Your Future in Am-

sterdam' e-mail project more positively than boys. Seventy-seven percent of girls liked the project or liked it very much, in comparison to 25% of the boys. The interviews indicated that the combination of the communicative nature of the program and the creative-writing element explain the girls' enthusiasm. Girls also liked the Image and Global Teenager e-mail programs more than boys. It was apparent in the interviews about Image that girls particularly enjoyed the contact with pupils in other countries, as well as the change from normal lessons that this project involved. More girls than boys felt that they had learnt a lot from this application. These differences are even clearer in the Global Teenager application. The boys emphasized that they found the practical implementation of the project less successful, whereas the girls pointed out that they would have preferred more personal, deeper contact with the other pupils.

Pupils from an ethnic-minority background liked the drill-and-practice program for primary schools better than pupils from the majority population and also thought they had learnt more from it. The language skills of the pupils from an ethnic-minority background in the research population had a negative influence on their assessment of Discovery Net, a program that requires a lot of reading and writing. They often found the texts difficult and hence did not like them much. There is also a difference in appreciation of the learning outcomes of Discovery Net: fewer pupils from an ethnic-minority background felt that they had learnt a lot from Discovery Net than pupils from the majority population. It is unclear whether this is actually the case. An alternative explanation may be that culturally determined ideas on what knowledge and learning are playing a role here. The questionnaires also indicate that secondary-school pupils from an ethnic-minority background find communication-oriented applications more difficult than pupils from the majority population.

3.5. Division of tasks and approach

The literature shows that girls and boys tackle working on a computer in different ways. To begin with, they are inclined to adopt different *roles* when working together on assignments involving ICT. Girls do the less technical tasks and do not sit as often as boys in the 'mouse position' (Barbieri & Light, 1992). They focus more on the group process whereas boys focus more on the work on the computer (Hoyles, Healy, & Pozzi, 1992; Pryor, 1995; Ching, Kafai, & Marshall, 2000). Such differences were apparent in our research in secondary education. In one of the secondary-school applications involving both communication and technology, teachers found that boys carried out the technical tasks more often, while girls produced the report.

In addition, the literature points out that girls prefer a particular learning *approach*, which results in a preference for ICT applications with particular characteristics. According to various sources girls have a preference for co-operative rather than competitive programs, for programs requiring creativity rather than skill, and place great importance on detailed, colourful illustrations (American Association of University Women (AAUW) Educational Foundation, 2000; Fiore, 1999).

With regard to ethnic differences in approach to working with ICT, we did find indications in the literature that not all pupils experiment with the computer with the same ease. This is possibly linked to ethnic background (Freedman & Liu, 1996).

In our questionnaire girls and boys in both primary and secondary education did indeed show different preferences in working with ICT (Table 7).

Table 7
Way of working with the computer at school, primary and secondary

Way of working primary/ secondary	Primary % agree	Gender differences		Ethnic differences		Secondary % agree	Gender differences		Ethnic differences	
		% Girls	% Boys	% Minority	% Majority		% Girls	% Boys	% Minority	% Majority
I prefer to work on the computer with others at school	54.3	52	57	65	48	40.7	43	37	54	38
I prefer computer games in which I can beat someone else	41.7	**31**	**55**	49	38	46.7	**38**	**62**	57	45
I prefer computer games in which you can make or build something, or in which you have to achieve something yourself (e.g., Rollercoaster or Sims)	57.3	61	53	**45**	**64**	59.8	63	56	57	60
When I am working with others I prefer to sit in the 'mouse position'	56.5	58	55	49	61	44.4	44	46	23	48
When I can do something well on the computer, I enjoy explaining it to others	74.6	**82**	**66**	78	73	62.2	67	56	57	63
I prefer playing computer games in which people experience things that really could happen	47.9	41	56	52	45	41.6	42	41	21	45
I prefer to try things out for myself on the computer rather than be given an explanation first	75.9	75	77	74	77	72.5	**62**	**89**	86	70

I prefer computer games in which I can imagine that I am one of the main characters	50.9	44	59	58	47	46.2	42	53	50	45
I prefer explanations on the computer to be in pictures rather than words	46.2	48	44	**60**	**39**	63.3	65	61	71	61
I really prefer computer programs or games to tell you whether you are doing it well	76.3	80	72	80	74	46.2	43	51	50	45
I prefer to play computer games with someone else	55.2	60	49	57	54	40.2	43	35	50	39
I prefer someone to explain to me what I have to do on the computer rather than working it out for myself	40.4	42	38	**58**	**31**	40.7	**57**	**17**	43	40
I like games and computer programs the most in which you can choose between lots of things	82.9	84	81	86	81	89.0	**83**	**97**	93	88
I prefer computer games and programs in which you can make something pretty or amusing	56.0	**66**	**46**	**77**	**45**	51.7	58	42	57	51

Girls at primary school enjoy explaining to others something that they can do well on the computer more than boys. Boys find it more enjoyable to be able to beat someone at a computer game, while for girls it is more important to be able to create something pretty with the computer. Primary-school pupils from an ethnic-minority background showed a preference for explanations in the form of illustrations rather than words, which is logical given the fact that they often experience a language problem, and for an explanation rather than trying something out themselves. They find it more important than pupils from the majority population to be able to make something pretty or amusing with the computer. Pupils from the majority population, on the other hand, have a stronger preference for computer games involving building or achieving something, like Rollercoaster or Sims.

We did not find any differences between secondary-school pupils from an ethnic-minority background and those from the majority population. There were a number of differences between boys and girls in terms of their preferences. In comparison to girls, boys do prefer games in which they can beat someone, programs with lots of choices and 'trying out something first and then an explanation'. More girls than boys prefer the opposite, i.e., having something explained to them rather than working it out for themselves. Teachers in both primary and secondary education said that boys work things out for themselves more whereas girls ask for help sooner.

The role in and approach of pupils to working with the specific applications also showed some gender differences. Pupils themselves and the teachers interviewed pointed out that girls prefer to work together rather than individually when using Image. When working with Global Teenager, girls try harder to find answers to the questions asked than boys, who give up more easily. Boys on the other hand try things out for themselves on the computer, while girls more readily ask for help. This corresponds with pupils' answers about their preferred approach in the questionnaire. It was also evident in the Coach application, where teachers saw that boys tried out more and investigated more on the computer, while the girls were more likely to write the report.

The more limited language skills of primary-school pupils from an ethnic-minority background are the main influence on their approach to ICT. They are more inclined than pupils from the majority population to skip reading passages because they are too difficult. In one of the primary-school applications we also found that pupils from an ethnic-minority background preferred to work alone rather than together but this can possibly be explained by the fact that there were less computers at their school, resulting in pupils working in larger groups. One of the teachers pointed out that when using the Coach program, pupils from an ethnic-minority background more often used a 'cook-book approach', i.e., they restricted themselves to following the instructions, scarcely experimenting on their own at all.

4. Conclusion

Our empirical research studied issues related to the use of ICT in which gender and ethnic differences have been identified in the literature, namely computer use in and out of school, computer skills, learning outcomes when ICT is used, pupils' attitudes towards ICT and their way of working with computers. In *primary education, gender differences* regarding all these points are small. *Ethnic differences*, however, do exist. First and foremost, fewer pupils from

an ethnic- minority background have a computer and an Internet connection at home than pupils from the majority population. The two groups of pupils use different ICT applications out of school. Pupils from an ethnic-minority background use the computer more often to practise what they have been taught at school (learning words, doing sums) but e-mail and surf less than pupils from the majority population. They use Internet less at school too. In addition, pupils from an ethnic-minority background use the computer at school less for writing papers. This possibly explains why pupils from an ethnic-minority background perceive themselves as less skilled than pupils from the majority population in word processing and Internet use. On a number of points pupils from an ethnic-minority background are more positive about computers than pupils from the majority population. Lastly, the two groups of pupils differ in their approach to working with ICT. Pupils from an ethnic-minority back- ground prefer an explanation to be in picture form rather than in words and prefer to be given an explanation rather than trying things out for themselves. It is highly probable that the ethnic differences identified in computer use and skills are linked to the characteristics of the school, such as ICT policy. The 'black' schools in our research group appear to use ICT differently than the relatively 'white' schools. Predominantly 'black' schools place more em- phasis on remedial work and drill and practice, while the other schools use computers in addition to this for communication and information skills. Pupils' answers in the questionnaire reflect these differences.

Unlike primary education, the *gender differences* found in *secondary education* were consider- able. Girls use the computer less at home than boys and programming and games in particular are unpopular. At school, both genders use computers equally intensively but girls e-mail more fre- quently, while boys play games more. There are few gender differences in ICT skills but many in ICT attitude, especially interest in computers and self-confidence in computer use. Girls and boys also differ in their approach to working with ICT, with girls preferring an explanation to trying something themselves and boys the other way round.

Ethnic differences in secondary education firstly concern the way in which pupils use computers out of school. Pupils from an ethnic-minority background use computers out of school less than pupils from the majority population for all kinds of writing activities (pa- pers, preparing talks, letters, reports and e-mails). As in primary education, they also use the computer less at school for papers and preparing talks, and more for practising skills. Sec- ondary-school pupils from an ethnic-minority background perceive themselves to be not as good at working with MS-Windows, presentation programs and e-mail. There are few dif- ferences in attitude and approach.

A limitation of our study is that we focussed on averages: mean group scores of girls and boys, and of pupils from an ethnic minority background versus from the majority population. Indi- viduals, however, will not always fit this group average. Moreover, the category 'ethnic minority pupil' is a very broad category. It should be noted that in our sample it consists mainly of pupils from Moroccan, Turkish and Surinamese lower-SES families. Our response group, especially in secondary education, was too small to further distinguish between ethnic groups in a valid way, or to explore the possible interaction between gender and ethnic group.

Generally speaking the gender differences in primary education in particular in the empirical research were smaller than the literature suggests. What was to be expected was that gender differences are greater in secondary than in primary education. The gender differences we found

are also pointed out in the literature, namely the attitude of pupils regarding ICT in general (but not specific applications), the division of tasks when working in small groups, and preference for a particular approach.

Ethnic differences in participation in ICT activities at school were clearly evident in our research group. This finding suggests that there are differences between schools in how they employ ICT depending on the pupil population. Differences between pupils from an ethnic-minority background and from the majority population in access to particular forms of ICT use out of school are thereby confirmed rather than compensated for.

Teachers did not seem to be very interested in the theme of ICT and diversity in the sense of attention to gender and ethnic differences between pupils. They generally already have their hands full with introducing ICT itself. For many teachers, the use of ICT in lessons constitutes a huge change, particularly for those who were used to the teaching and learning process being organized on a whole-class basis. The fact that many pupils have acquired a lot of ICT skills out of school (often more than teachers themselves) leads some teachers to surmise that the school has no specific role to play here. We dispute this vision, which we also encountered in the literature (De Haan & Huysmans, 2002), on the basis of our findings. The observation that differences between pupils from an ethnic-minority background and pupils from the majority population that originate out of school are confirmed rather than compensated for, is a clear indication that the theme of ICT and diversity should feature more prominently in the policy of schools than it does at the moment.

To conclude, we will formulate a number of strategies for a diversity-oriented ICT policy at school level on the basis of the results of our research. The differences identified between pupils from an ethnic-minority background and pupils from the majority population in terms of access to ICT applications and ICT skills, especially in primary education, give schools an important role to play in compensating for these differences. It is important to ensure that all pupils have the chance and are stimulated to acquire computer experience of different kinds. An 'ICT-skills learning line' should be able to ensure that all pupils acquire a command of the necessary skills. Out-of-school activities can support schools in this task. It is important that parents who cannot or do not want to buy a computer and/or Internet connection encourage their children to make use of such facilities elsewhere, for example in the public library or community centre. In out-of-school activities it is also important to ensure that both girls and boys have adequate access.

We also observed differences between pupils from an ethnic-minority background and pupils from the majority population in the use they make of ICT at school. Although we cannot generalize this finding, it seems that schools with many disadvantaged pupils are insufficiently aware of the value of working with Internet, e-mail etc. and are inclined to restrict themselves to working with drill-and-practice programs. It is particularly important that pupils from an ethnic-minority background also use ICT applications involving Internet and e-mail. In this way they can acquire skills that will be of importance in their further school career. The fact that these applications demand a high level of reading and writing skills must be taken into account. On the other hand, e-mail and Internet projects are a particularly meaningful and motivating way for these pupils to improve their language skills.

Two different strategies can be derived from the results on gender differences. If the fact that there are fewer gender differences in attitude regarding ICT in younger pupils is interpreted as a generation question, we can assume that the differences will disappear in the next generation. But

while this difference can still be interpreted as a question of age, we must pay attention to changes in girls' attitudes towards ICT at the beginning of secondary education. It is important in both primary and secondary education that girls encounter positive role models in ICT use (for example, women teachers with extensive expertise in ICT and a positive attitude towards its use) and with ICT applications that they find attractive.

The literature and the empirical data on secondary education both indicate that a gender-specific division of tasks easily emerges in working with ICT. Teachers must be aware of this and correct an unbalanced division of tasks, for example by explicitly discussing the division of tasks in the class. When pupils work together in mixed gender groups, teachers can rotate roles and tasks. Explicit attention to *learning* to work together and *learning* to divide tasks fairly is important.

Different ICT applications do not seem to appeal to the same extent to all pupils. In the empirical research we were mainly confronted with applications that girls like better than boys, which is particularly interesting as secondary-school girls' answers to the questions on ICT attitude were less positive. It confirms the opinion already expressed in the literature that creative and linguistic applications are a suitable means of encouraging girls to use ICT.

The development of software and websites that are free of gender stereotypes and cultural prejudices are an important strategy mentioned in the literature. Taking the preferences and sensitivities of different groups of pupils regarding the content, design, patterns of communication and learning styles into account is also an important theme in the literature. The applications we studied appear to fulfil the criteria on gender and cultural sensitivity reasonably well. In the empirical research, the teachers did not consider other ICT applications that they use to be a problem in this respect either. Opinions are divided on to what extent an ICT application should take such social differences between groups of pupils into account. It is considered to be far more important that programs fit in with the different levels of achievement and different interests of pupils.

Both the literature and the empirical research indicate that it is advisable to pay attention to pupils' preferences regarding the instructional structure of ICT applications. Teachers and software/content developers must not assume, for example, that all pupils like experimenting and sorting out how something works for themselves, etc. The use of a variety of ICT applications is important to meet the preferences of different pupils regarding approach and interests. At the moment this is still very much a matter of chance. Teachers should also stimulate pupils gradually to build up learning strategies that the teacher considers to be important for the development of the pupils (for example, trying something out themselves before asking). Gender sensitivity and cultural sensitivity remain, in our view, important criteria for the development and selection of teaching materials.

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