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Inclusiveness and ICT in education: a focus on gender, ethnicity and social class

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Abstract

This paper presents the results of a literature review on gender, ethnic and socioeconomic status differences related to ICT in primary and secondary education. The review was conducted in order to develop an index for analysing the inclusiveness of educational ICT applications. The research question was: 'How and to what extent do the characteristics of educational ICT tools enhance or inhibit learning for different groups of students?' A discussion of both research- and practice-oriented literature results in a proposal for such an index. The paper concludes with a discussion of various dilemmas associated with the idea of the index, and of the ways in which it may be used in research and educational practice.

Keywords:

gender, ICT use, primary and secondary education, race/ethnicity, social class

Introduction

In recent years, ICT has acquired a place in education, as it has in most other sectors of society. Since the 1980s many computer applications have been developed for educational use – programs for drill and practice, instructional programs, and simulations are now available for many school subjects. Besides these, a number of general programs have found their way into the classroom, where they are being used as learning or work tools (e.g. word processing programs, databases and spreadsheets). More recently, email and Internet access have become available to schools. Not only are these ICT applications seen as substituting for existing learning tools, but they are also being used to promote a new kind of learning in which teachers support and coach students' learning processes instead of merely transmitting knowledge to them (e.g. de Corte *et al.* 1996; Bransford *et al.* 1999). Simulations

and multimedia programs, for example, offer opportunities to engage students in solving 'real' problems encountered in daily life. The Internet makes it possible to provide problems and assignments that are realistic and up to date, and facilitates communication with the world outside the school. ICT also facilitates differentiation and individualization in education: it makes it possible to tailor both the content and the presentation of the subject matter to the individual backgrounds, experiences and needs of students (e.g. DeVoogd 1998; Gillani 2000). Although evidence that ICT improves learning and learning results is scarce, students appear to like the use of ICT at school and to be motivated by it (Maurer & Davidson 1999). The opportunities for differentiation combined with students' positive experiences with ICT have recently led to the assumption that the use of ICT contributes to educational equality (Becta 2002).

However, the relationship between the use of ICT and equality/inequality in education is far from unequivocal. Whereas some claim that the use of ICT favours disadvantaged students, in the literature others point out several ways in which ICT may increase inequality in education. First, it is likely that the digital

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divide between computer haves and have-nots and those who do and do not have access to the Internet – a divide that follows the traditional lines of race and social class (Novak & Hoffman 1998; de Haan & Huysmans 2002) – results in differences in the ICT knowledge and skills that students acquire outside school. A teacher's expectation that his or her students are skilful computer users may disadvantage those who have not had the chance to acquire these skills.

Second, although by now virtually all Western schools have computers and Internet access, they appear to differ in the ways they use these facilities (Becker & Ravitz 1998; Volman *et al.* in press). Poor and minority-group students are more likely to use computer for drill and practice activities, while their affluent white peers are more likely to use advanced technology tools and/or the Internet. Even within schools differences occur between students in the extent and kind of computer and Internet use (Schofield & Davidson 2002; Solomon 2002).

Third – and this aspect is the most difficult to grasp – differences between students may originate when working with ICT, because certain ICT applications are not equally accessible or attractive to all students, owing to their experiences outside the school, interests, attitudes and learning approaches (e.g. Chisholm 1995; Damarin 2000). The differing appeal of ICT applications to different groups of students has, in particular, been described in the literature on gender and ICT (Volman & van Eck 2001). Gender differences in ICT knowledge and skills, in participation in activities involving computers at school and in computer attitudes have been explained by pointing out that not only computer games but also educational software is often unintentionally tailored to the interest of boys. The development of gender-inclusive educational software has been advocated for many years now. More recently, similar arguments have been formulated in relation to differences between ethnic or cultural groups, and a plea has been made for increased cultural sensitivity where the use of ICT in education is concerned (e.g. Reeves 1997; Damarin 1998; Gillani 2000).

In this article we build on this line of thought and analyse the accessibility and attractiveness of ICT applications to different groups of students, focusing on gender, class and cultural inclusiveness. We combine an educational perspective on teaching and

learning with insights from the sociology of technology, in order to interpret the literature on inclusiveness and ICT in education. It is emphasized in educational theories that learning is fostered when students are actively engaged in activities that are meaningful to them (e.g. Simons *et al.* 2000). The sociology of technology contributes to the understanding of how the design of educational tools may inhibit the active involvement of students in learning. Analyses from a sociology of technology approach show that technological artefacts are never neutral, but always imply human choices. Assumptions about the supposed user and the way he or she will use the artefact are incorporated into the design of, for example, bicycles, microwave ovens and electric shavers. Computers and software, including educational software, are not neutral media (Chisholm 1995) and these assumptions – or 'scripts' (Woolgar 1992; Akrich 1995) – are built into them, too. 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 (DeVaney 1998). The resulting scripts will usually function unconsciously, as a part of the 'hidden curriculum'. When these scripts are not suited to certain groups of students and these students are not able to identify with the supposed user, this may inhibit their learning. Ultimately, this can result in differences in participation, attitudes and learning outcomes in both ICT itself and subjects in which ICT is used as an educational tool.

In order to provide for inclusive education in technology-rich learning environments it is therefore necessary to obtain an insight into these scripts and to identify the underlying characteristics built into ICT applications that may enhance or unintentionally restrict the attractiveness and accessibility of learning to different groups of students. With this objective in mind, we conducted a literature review on gender, ethnic and socioeconomic status (SES) differences related to ICT in primary and secondary education. The following question guided our literature search and analysis: *How and to what extent do the characteristics of educational ICT tools enhance or inhibit learning for different groups of students?* After describing the search, we answer the research question based on an analysis of the literature we reviewed. In the second part of the article, the results of our review

are used to identify the characteristics of inclusive ICT applications for education, which are presented as an 'index of inclusiveness'. In the final section, we discuss ways in which this index can be used in research and educational practice, and go into some of the problems associated with the idea of such an index.

Method and search results

We searched the SSCI and ERIC databases for the period 1992–2002 using the descriptors computer*/educational technology-ethnic*/socioeconomic*-elementary/primary/secondary education. We then searched the same databases for the period 1999–2002, using sex/gender as the second keyword. We used Volman and van Eck's (2001) review on gender and ICT in education for literature from the period 1992 to 1999.

Many of the articles we found did not focus on ICT tools and their effects, but described differences in participation in ICT activities (i.e. differences concerning who works with which tool, does what, how and when) and differences in computer attitudes between students. We did not select these articles for our review, as our research question does not concern the existence of differences in general, but the possibility to explain such differences in terms of the characteristics of ICT applications, namely scripts. However, we did select those articles that describe differences in participation between social groups when working with the same ICT tools, because such studies shed light on the issue of scripts in educational software. ICT resources for multicultural education – which are meant to acquaint students with and teach them respect for different cultures – turned out to be an often discussed issue in the literature. We only selected these articles, however, if they also addressed the question of inclusiveness in terms of the characteristics of the teaching material. There appears to have been relatively little empirical research on the issue that interested us most, namely the differential impact of the characteristics of ICT as an educational tool on the learning processes and the learning results of different groups of students. We did, however, find a considerable number of theoretical or reflective articles on this issue. We decided to select both empirical and non-empirical studies and practice-oriented articles (e.g. guidelines for cultural sensitivity) for the

review. After applying these selection criteria, the search produced about 50 relevant titles.

The large majority of the articles found concern gender differences, with a more limited number of publications focusing on race/ethnicity, and a few discussing socio-economic or class differences, often under the broader heading of equity. Studies taking an integrated approach to gender, race and class are scarce, as Sutton (1991) and Volman and van Eck (2001) have already remarked. A great variety of ICT applications are discussed in the literature, for example, drill and practice or instructional programs concerning specific subject matter, Internet/web-based programs, computer-mediated communication (CMC) and integrated learning environments. Many of the empirical studies were small scale – for instance, on the experiences of different groups of students while working with ICT tools – or case studies in which it was investigated as to how ICT is used in diverse classrooms. The majority of the literature has a prescriptive character and formulates guidelines for the development and use of educational ICT tools based on a theoretical analysis of the learning needs and preferences of particular social groups. There is a general lacuna in research on ICT and education concerning the relationship between learning outcomes and the use of ICT (e.g. Wilson 1999; Bain *et al.* 2000), and we found hardly any studies that linked the issues of the characteristics of the design of educational ICT tools to the learning outcomes of students.

In the literature, a number of characteristics are discussed that are supposed to be relevant in terms of the gender or cultural inclusiveness of ICT applications. A first analysis of the literature revealed three major topics into which these characteristics could be grouped. The first is the content of educational ICT tools: to what extent and how does the content of such tools enhance or inhibit learning for different groups of students? The dominance of visual and audio information is one of the main factors distinguishing ICT educational tools from other teaching materials. The second topic is the gender inclusiveness and cultural sensitivity of the visual and audio interface, which includes the navigational structure of the ICT tool. The third topic concerns the characteristics of the instructional structure of ICT tools: to what extent and how do the instructional characteristics of such tools

fit in with the needs and preferences of different groups of students? In the following sections, we review the literature according to these three topics. The results are then translated into an index for the gender inclusiveness and cultural sensitivity of ICT tools.

Content of educational ICT tools

The literature contains various analyses of ways in which the content of programs or websites may alienate groups of students, reports on attempts to develop programs whose content is 'inclusive' and guidelines for developing or selecting such programs. Before going into details, however, we first sketch the types of studies we encountered in the review regarding the content of educational ICT tools. All articles mentioned are discussed more extensively below.

First and foremost, it should be noted that few authors actually empirically investigated how students and teachers experience the gender inclusiveness or the lack of such and particularly the cultural sensitivity of ICT materials. The studies by de Jean *et al.* (1999), Lu *et al.* (1999), Fiore (1999) and Agosto (2001) are exceptions to this. Research into the effects of the inclusiveness of ICT applications on learning outcomes is even scarcer. The only example we found is the work by Joiner *et al.* (1996). Further, we came across publications in which detailed analyses of software or websites are presented, or in which curriculum design is the central issue (Biraimah 1993; Hodes 1996; Bigelow & Larson 1999; Furner *et al.* 2000). The remaining studies concern theoretical arguments for sensitivity to cultural differences (Roblyer *et al.* 1996; Reeves 1997) or practice-oriented reflections on theory and research, arguing that one should recognize students' individual backgrounds when developing or using multimedia and the Internet in education (Henderson 1996; Adler 1999; Larson 1999; Gillani 2000). Finally, authors describe the construction of culturally inclusive websites (Irwin *et al.* 1994; McLoughlin 1999).

The common argument in articles on the content of educational ICT tools is that in order for the subject matter to be meaningful to all students, there must be no obstacles for students to identify with. This should be achieved by taking a *perspective* that is multi-cultural, non-sexist and respectful of different social classes.

Firstly, a number of publications focus on the way in which people of different gender and race are presented in educational materials. It has been argued for a long time that in order for textbooks to be inclusive, a balanced presentation of diverse human groups is required, for example men and women, people with different ethnic and cultural backgrounds or religions, etc. The same argument is made with respect to digital educational materials. Analyses, however, show that such a balanced representation is not always provided. Biraimah (1993) and Hodes (1996) analysed software for American primary and secondary schools, and found that female characters are still featured less often than male characters are, and that non-white and non-Anglo-American characters are not frequently depicted.

Many authors point out that it is important to look beyond the mere presence of different groups. Women and blacks are often presented in stereotypical roles and exhibit stereotypical behaviours, and social groups are not always presented in a way that accurately reflects their contributions in a certain area (Roblyer *et al.* 1996; Reeves 1997; Adler 1999; Bigelow & Larson 1999; Agosto 2001). A frequently chosen way to 'include' women or non-whites is not by integrating them into the basic content, but by discussing their position or contributions in a separate section or special box in the program, which students can choose whether or not to read. Henderson (1996) argues that this is a superficial way of making a program multi-cultural or gender inclusive.

Many researchers mention the issue of the perspective that is taken in presenting a subject. It is argued that educational ICT programs often unwittingly take a Eurocentric and male-oriented perspective, by omitting non-Western or feminine worldviews, ideas and beliefs or by presenting them only superficially (Roblyer *et al.* 1996; Reeves 1997; Adler 1999; Larson 1999; Gillani 2000). An illustration of this is Bigelow and Larson's (1999) analysis of *The Oregon Trail*, a simulation about the westward migration in the 1840s in the US that was meant to be a cultural and gender-fair program. The authors show that although women and Indians appear in the simulation, their stories and experiences and their contributions to the journey are not included. Although taking an inclusive perspective may seem especially relevant in such subjects as history, languages and geography, Furner

et al. (2000) describe a fourth-grade mathematics course in which the Internet was used to investigate Mayan mathematics. The authors consider the investigation of the use of mathematics in diverse cultural and historical contexts as a way both to enhance students' understanding and respect for each other's culture, and to introduce them to the evolution and logic of mathematical systems. De Jean *et al.* (1999) studied how girls experienced working with a mathematics computer game explicitly designed to appeal to girls by, for example, having a girl as the central figure in the story. Their results show that girls liked this game especially because the leading character is a female. Interestingly, boys too were enthusiastic about it. Girls also appreciated the fact that they could correspond with (i.e. write letters to) the figures in the game and that the game was about solving concrete problems.

Larson (1999) combines a number of the issues discussed above in a series of guidelines for selecting equitable electronic software. These guidelines recommend asking, for example – and these questions look for more than the mere presence of social groups – are groups represented in ways that reflect the diversity within these groups? Are a variety of groups portrayed in a variety of occupational tasks and careers? Are all groups involved in such ordinary tasks as household and parenting? Are all groups developing independent lives and finding their own solutions? Are all groups portrayed as having a range of human responses and in a variety of situations, including interacting with others?

Another aspect of the cultural sensitivity of educational ICT tools is the question whether the content is respectful and *considerate of the values, manners and taboos* of different cultural groups. It is argued that a large number of programs lack accuracy, depth, complexity and/or sensitivity in relation to non-mainstream cultures. Reeves (1997) gives the example of a story in an ESL (English as a second language) program, in which a boy is anxious because he is about to meet the new boyfriend of his mother for the first time. Chinese people found this story offensive because it was felt to be disrespectful to their values of the importance of the traditional family. A dilemma that is not easily solved is that this story was probably trying to be considerate to children from broken homes. Lu *et al.* (1999) report on a comparative evaluation

of software performed by American and Taiwanese teachers. One of their examples is a program with a story featuring a farting mouse. Many Americans found this vulgar or offensive, whereas it was fully acceptable to the Chinese teachers. Finally, Larson (1999) and Gillani (2000), for example, warn against the use of sexist or racist language.

In the literature on gender-inclusive science education, the importance of presenting the subject matter in a '*real-life*' context has been pointed out since the 1980s (e.g. Rosser 1989). Girls have been shown to be more interested in science subjects if these are treated in the context of their practical applications. This argument is also found in the literature on ICT and gender (Selby & Ryba 1994; Volman 1997; Agosto 2001). In relation to cultural differences this issue is less salient, although Adler (1999) suggests that Australian Aborigines prefer learning through people-oriented tasks and context-specific skills, rather than abstract, generalizable skills. Also, others mention the importance of this. McLoughlin (1999), for instance, describes the development of a culturally sensitive Web design for adult Aboriginal students, which is based on a community of learners. She emphasizes that in order for the educational program to be accepted by the students, it should be an authentic learning environment based on subject matter that is relevant to them. Irwin *et al.* (1994) describe the development of a multicultural website for literacy learning. Incorporating the life experiences and background knowledge of the students involved is an important part of the program, because it helps students to relate to the material and serves as a foundation for learning. Recently this issue has been taken up more generally in educational psychology from a constructivist point of view. By now it is more or less generally accepted that engaging students in solving authentic problems motivates students, produces outcomes that are meaningful for the learners and leads to deeper learning (Simons *et al.* 2000). ICT can play an important role in organizing such learning processes (Bransford *et al.* 1999; Maurer & Davidson 1999).

A final issue discussed in the literature is the importance of making ICT applications attractive to different students by *addressing different interests*. Again, most research in this area focuses on gender. It was argued early on that many computer games are modelled after games typically played by boys, thus

alienating girls from using the computer. Later, several studies investigated what kinds of software girls find attractive, and software has now been developed that tries to take this into account. Joiner *et al.* (1996) experimentally compared the effects of different versions of software that were assumed to appeal more either to boys or to girls. They investigated the performance of girls and boys in two versions of an adventure game, namely a 'male' version with pirates and a 'female' version with princesses. Girls scored less well than boys in both versions of the game, even when computer experience was taken into account, but scored relatively higher in the version they preferred, usually that with the princesses. Boys had a less pronounced preference for one or the other version and no differences in performance were found. Given these results, the researchers emphasize the importance of developing software that is appealing to girls. The differences in performance between boys and girls in the preferred version, however, remain to be explained.

Fiore (1999) formulated a number of recommendations regarding the content of software on the basis of a literature study and interviews with girls aged from 5 to 22. She claims that girls prefer adventure, friendship and creativity in the storyline rather than action, violence and playing to win, although they do like sport and racing. They appeared to prefer complicated plots and design assignments to simple 'rule-based, die-and-start-over' scenarios. This can involve a broad spectrum of subjects ranging from looking for solutions to complex social problems, through designing interiors and clothes, to bungee jumping and travel. Opportunities for personal exploration were greatly appreciated. Girls indicated that they like to explore their own feelings and problems, experiment with different clothes and hairstyles and see how people react to them in certain situations. They also appeared to appreciate it when their own products (e.g. drawings, words or stories) are included in the story or game. Girls were found to loathe stereotypes of themselves and games that are too 'girly' (e.g. skirts but no trousers hanging in the wardrobe), and to like tough, active female characters. In addition, they preferred working together and interactive communication to competition, which did not automatically exclude group performance and self-improvement. Similar conclusions are drawn in the

report of the American Association of University Women (AAUW) Educational Foundation (2000).

When it comes to the question of how exactly these findings and guidelines should be included in the development of ICT materials for education, a problem arises: it seems infeasible to take each student's interests, cultural background, etc. into account in one and the same program. This problem recurs in several forms in this paper, and is discussed more extensively in the conclusion.

Visual and audio interface of the educational ICT tool

In our review, we encountered quite a number of articles that look closely at the visual and audio structure or architecture of ICT tools. A reason for this is that in comparison with such traditional teaching materials as books, the impact of educational ICT applications on the learning processes of students takes place for an important part through the applications' visual and audio appearance. The discussion of these issues in the literature addresses largely the same issues as those addressed in the previous section of this paper.

Visual aspects of the program

When the images in an ICT program are at stake, questions similar to those related to the content of the program are asked: is a diversity of groups of people present in the pictures, illustrations and graphics of the program? Are they represented in a non-stereotypical way? Are cultural values, customs and taboos treated in a respectful way? (cf. Roblyer *et al.* 1996; Reeves 1997; Adler 1999; Larson 1999; Gillani 2000). Again the main argument is that a restricted or stereotypical way of presenting ethnicity and gender in a program conveys a negative message to students, which can have an alienating effect on those who cannot or will not identify with the character(s) in the software. Presenting a more balanced number of male and female characters appears to be a better solution than introducing gender-neutral characters. In the present cultural and social context – which is dominated by the binary antithesis of man/woman – the latter strategy is doomed to failure. Bradshaw *et al.* (1995) found that primary school students themselves attributed a

gender (usually male) to the genderless figures in their program.

The issue of how to be considerate of different cultural values and taboos in the images used in a program is one of the more complex issues in the design of culturally sensitive educational materials (see Reeves 1997). Pictures of certain animals, for example, may be offensive to some religious groups. The same holds for pictures of heads and hands, which are often used as icons. The use of colour leads to similar problems; for example white is the colour of mourning in some cultures and of hope in others.

Another issue concerns students' preference for a specific graphic design. The visual communication of a program, as Gillani (2000) puts it, should attract different students. She argues that in African cultures the use of bright colours is often preferred. Fiore (1999) found that girls like a lot of detail and bright colours, whereas boys prefer more dark colours. More in general, good-quality pictures and videos are necessary to capture the interest and attention of young people (Agusto 2001). Also, these visual communications should be clear and easy to understand. In addition to the character of the icons used, a number of other characteristics of the interface are discussed in the literature. The position of icons and the menu is a relevant issue when a language that must be read vertically or from right to left is involved (Henderson 1996; Reeves 1997; Gillani 2000). Agusto (2001) notes that it is important for users to be able to follow their own navigational path; especially young women prefer electronic resources that allow for multiple paths and many possible answers, and not just one 'right way of doing things'.

The issue of attractiveness thus outreaches the program as such. Sutton (1991) also looked at photographs in computer magazines and in advertising, and Larson (1999) suggests that one should look at the packaging of a program and question whether the pictures used are attractive to a diverse student population.

Audio

Two issues concerning the audio aspects of ICT program are addressed in research on ICT applications. Firstly, the use of voice is taken into account. Larson (1999) and Agusto (2001) suggest that the narrators in

a program should have a range of different voices – both male and female – as well as different accents. It is preferable that the accents used be familiar to the students (Royer *et al.* 1994).

Secondly, it is suggested that the sound track should include a variety of sounds and music styles (Roblyer *et al.* 1996; Reeves 1997; Larson 1999; Gillani 2000). Fiore (1999) found, for example, that many girls do not like the electronic music used in the software games designed for boys (cf. Agosto 2001).

Some of the studies discussed in this section tend to generalize quite readily, and their results do not always seem to reflect the differences within particular social groups, cf. how prevalent is a preference for bright colours in African cultures, or a dislike of electronic music among girls? Nevertheless, these studies make clear that using a diversity of (selectable) visual and audio features can make ICT tools more attractive to a diversity of students.

Instructional structure of an educational ICT tool

The inclusiveness of the instructional structure of an ICT application is the extent to which the way the learning process is structured by the program, or the kind of learning processes that are facilitated by it, fits in with the levels and learning approaches of different groups of students. Again, the argument is that every student in a program's target group should feel both comfortable and challenged when working with the program. Since the instructional structure of the educational ICT tool emerges from our review study as a frequently discussed issue and includes different types of analyses and research, we first present a brief overview of the kind of studies we encountered.

Comparatively speaking, more empirical research is carried out into the instructional structure of ICT tools than into the other aspects of the inclusiveness of ICT applications, although few authors explicitly investigate the inclusiveness or otherwise of ICT materials. Most empirical research has concerned studies on gender differences when working with ICT, focusing on collaboration (Hoyles *et al.* 1992; Selby & Ryba 1994; Pryor 1995; Ching *et al.* 2000; Kafai 2002), group composition (Barbieri & Light 1992; Kutnick 1997; Underwood *et al.* 2000) or CMC (Savicki *et al.* 1996; Hsi & Hoadley 1997; Gougeon 1998; Barrett & Lally 1999; Fabos & Young 1999; Wilson

2000). Most of the studies were carried out in regular classrooms (e.g. Hsi & Hoadley 1997; Ching *et al.* 2000), although some were designed as quasi-experiments (e.g. Kafai 2002). Fewer empirical studies focused on cultural differences or equity: the only ones we found are the quasi-experimental studies by Freedman and Liu (1996) and by Royer *et al.* (1994), and the case studies by Chisholm (1995), Maurer and Davidson (1999), DeVoogd (1998) and Uptis (1998). The study by Hativa *et al.* (1993) is the only study on SES differences. Volman *et al.* (in press) combine gender, SES and cultural differences when describing how students work with ICT. Besides empirical studies, we came across practice-oriented articles stressing the importance of recognizing students' individual backgrounds when developing or using ICT in education (e.g. Ikegulu 1997), as well as theoretical articles analysing cultural issues in educational technology (e.g. DeVaney 1998; Joo 1999).

Prior knowledge and learning strategies

First of all, the instructional structure of the educational ICT tool refers to the extent to which different *initial levels* of students are taken into account. Research shows that girls generally report fewer ICT skills and less ICT knowledge than boys do (Volman & van Eck 2001), and that students from ethnic minority groups less often have access to computers at home (Novak & Hoffman 1998). As a consequence, programs should offer instruction or tasks at various levels of difficulty in order to allow for differences in computer skills and knowledge, and/or should allow the student to seek help from peers or adults (Chisholm 1995; Maurer & Davidson 1999). Furthermore, students differ in specific content knowledge and learning capabilities. Also, these initial differences should be anticipated by, for example, providing a variety of programs at different levels (Adler 1999).

A related issue is the fact that students may have a *home language* that differs from the instructional language used in the program. Not only the technical language skills but also the cultural codes of students are an obstacle to working effectively with a specific program (e.g. Royer *et al.* 1994). Joo (1999) shows that writing styles and structures may alienate students who have a non-dominant language. For example, conventions of politeness in daily language and levels

of abstraction used in education may differ between languages. Translated texts may appear elusive or even threatening as a result of their directness. Several authors point to the possibility to develop programs with multilingual capabilities in order to offer learners more flexibility (Ikegulu 1997; Adler 1999; Gillani 2000), or make a plea for such measures as adding explanatory dictionaries (Larson 1999).

Cultural differences in *learning strategies* is one of the central issues in studies on the instructional characteristics of ICT applications. It is argued that programs should accommodate students' preferred learning strategies, which may be related to their gender and/or culture (Irwin *et al.* 1994; Chisholm 1995; Freedman & Liu 1996; Henderson 1996; Ikegulu 1997; Adler 1999; Larson 1999; McLoughlin 1999). Many examples are given in the literature of cultural differences in learning strategies – or learning styles – and it is argued that much educational software is unintentionally tailored to a Western approach to learning (e.g. Henderson 1996; DeVaney 1998). For instance, Adler (1999) argues that in Mexican–American and African–American cultures, learning is characterized by cooperation and interdependence, while the Anglo-Saxon culture values independence and self-reliance in learning (cf. Chisholm 1995). A related issue concerns the critical attitude towards teachers and knowledge, which is generally considered as typically Western (Henderson 1996; Reeves 1997). In an empirical study by Freedman and Liu (1996), the ways in which Asian–American and non-Asian American students in secondary education (grade 7/8) used the computer were compared. Although a questionnaire and interviews did not reveal any differences, observations showed that Asian–American students approached the computer less creatively and did not experiment as much as the other students. The authors relate this to their cultural backgrounds and experiences, which explains their reluctance to make mistakes. From a more practice-oriented perspective, Irwin *et al.* (1994) used suggestions and feedback from teachers and students to make the multicultural website that they developed compatible with various learning strategies, cultural backgrounds, interests and needs. Furthermore, the authors argue that by using hypertext links every user can go through the material according to his or her own learning preference.

Other differences in learning approaches we came across were: learning by real-life performance versus learning from simulations or in artificial settings; learning by trial and error or observation and imitation, versus learning by oral or written instruction; and a focus on people-oriented tasks and mastering context-specific skills, versus a focus on abstract generalizable skills (McLoughlin 1999).

In relation to learning strategies, there is the question of accommodating the existing strategy as opposed to trying to extend or change it. Most authors take the position that existing preferences must be both acknowledged and taken as a starting point for the acquisition of a broader range of learning strategies (Henderson 1996; Adler 1999). Exemplary of this position is Henderson's plea for a multiple cultural model for the design of interactive multimedia that aims at integrating academic, mainstream and minority cultures, and 'acknowledges that ethnic/racial minorities have little choice but to become bicultural if they are to succeed academically' (1996, p. 95). According to Henderson, students appreciate this integration because the incorporation of their culture into the learning materials can be used as a place from which they can start mastering academic genres and other approaches to learning.

Collaboration and communication

A number of authors focus more generally on the kinds of *learning activities* favoured by a program. Particularly the issue of social interaction required by learning activities appears to be relevant, both in terms of culture, social background and gender and in terms of students' achievement level (Adler 1999; McLoughlin 1999; Gillani 2000). This refers both to the question of collaboration versus competition, and to that of which opportunities a program offers for communication.

Research on gender reveals that girls prefer collaboration to competition (Selby & Ryba 1994; de Jean *et al.* 1999; Fiore 1999; Agosto 2001). On the basis of a study into the effect of competition on low achievers and disadvantaged students (low SES), Hativa *et al.* (1993) concluded that these students have more negative feelings about competitive programs and failing than others do. When collaboration is required in the learning process, the division of tasks and roles be-

tween students requires attention (Larson 1999). Differences in task orientation are an important theme in research on gender differences and ICT (Volman & van Eck 2001). Several studies found that boys appeared to be more computer-centric in the sense that they seized every opportunity to work on a computer while girls concentrated on the group process (e.g. Hoyles *et al.* 1992; Ching *et al.* 2000). However, this seems to be a difference not only in task orientation but also in learning opportunities. Several authors found that girls working in mixed pairs in primary and secondary education had less chance to work on the computer (e.g. Barbieri & Light 1992; Pryor 1995) or were given the less technical, lower-status tasks (Ching *et al.* 2000). Following this line of research, the group composition while working on a computer is taken into account. However, no unequivocal results are available as to which group composition (i.e. same sex or mixed) is best in terms of achievement (Barbieri & Light 1992; Kutnick 1997; Underwood *et al.* 2000). Interventions aimed at teaching students strategies for working together seem promising (Pryor 1995; Ching *et al.* 2000).

The role of opportunities for communication features in the literature is a contested issue with regard to different groups of students. Agosto (2001) argues that women tend to value computers for their ability to connect with others, which might explain Nordli's (2000) finding that girls in particular like the multimedia and Internet options of the computer. But while programs that offer opportunities for communication with others (e.g. with experts through email or chat) seem to be appropriate for women, their use can be problematic for other groups (e.g. McLoughlin 1999). For example, asking why-questions or having a different opinion from and arguing with others, particularly adults, is not a natural part of the culture of some ethnic groups (e.g. Freedman & Liu 1996; Henderson 1996; Collis & Remmers 1997; Reeves 1997). Moreover, communication can be complicated by differences in language proficiency (Joo 1999).

Research on gender differences addresses more specifically the effects of CMC. Hsi and Hoadley (1997) report on a study in which eighth-grade students were helped to learn about thermodynamics by means of electronic discussion. The comprehension of the physics material was enhanced in all the students as a result of their participation in the discussion. The

students' participation, however, appeared to be more gender equitable and the girls liked the electronic discussion far more than the boys did. The girls appreciated having time to think before they responded and being able to respond anonymously; they also liked the absence of immediate negative comments from their male classmates. Boys did not prefer the anonymous option, but used the option of responding with name and picture. However, also regarding CMC it has been found that gender differences interact with cultural differences. Contrary to adult white women, the Hispanic women in Wolfe's (2002) study preferred face-to-face communication, because in CMC the non-verbal communication was lost. The doubts others have about the presumed equalizing impact of CMC concern the incentives to react that may be lost rather than increased for some students in asynchronous communication (Fabos & Young 1999) or – again – the language skills such communication requires (Volman *et al.* 2003).

In addition to studies on students' experiences with CMC, the characteristics of men's and women's contributions have been investigated. Barrett and Lally (1999) found that men tend to write more and longer messages containing more social talk. Women's messages were shorter, more task oriented and more interactive, that is, they used more references to the writings of others. Other authors, however, found an equal or even higher participation rate (i.e. number of messages sent) and that women wrote longer messages (Savicki *et al.* 1996; Wilson 2000). Finally, gender differences in communication styles have been found (e.g. Savicki *et al.* 1996; Gougeon 1998). It remains unclear, however, to what extent these differences are related to learning outcomes.

A final issue with respect to learning activities is the kind of skills that are addressed in a program. Research on gender differences indicates that girls prefer activities that are creative and social, such as writing and drawing (de Jean *et al.* 1999; Fiore 1999; Passig & Levin 1999).

Self-confidence

An important aspect of the instructional structure of an ICT application is the manner in which a student can receive *help*. Many authors mention the importance of clear and immediate feedback and good scaffolding

support in general (Selby & Ryba 1994; Adler 1999; Gillani 2000). But according to Agosto (2001), boosting the self-confidence of students is especially important for girls to counteract gender-related self-doubt when working with computers.

Another way to promote self-confidence and provide support is to encourage students to help each other (Selby & Ryba 1994; Uptis 1998) or to work with expert students (Selby & Ryba 1994; DeVoogd 1998; Maurer & Davidson 1999; Gillani 2000). Especially when working with expert students it is important that the experts have been trained in the social aspects of helping others (Maurer & Davidson 1999). The first and second graders in their research learned to work well with their peers and behaved professionally in their expert roles – although at first they were interested primarily in manipulating the technology rather than in helping their peers to learn. The extent to which students seek support from classmates seems to be related to differences between students. Uptis (1998) found that students who were not eager to use the computer in the classroom did not ask for help from their classmates, or were unaware of the help their peers could provide. This is in contrast to students who liked the computer and/or used it frequently. The results of the study by Kafai (2002) show that girls receive and give more help in collaborative software design activities than boys do. Uptis (1998) mentions the important role the teacher can play in helping students to find ways to obtain support. What is at stake here is not only the characteristics of the software but also the context and the ways in which it is used.

A final issue in the literature related to the instructional characteristics of ICT programs is the extent to which students are allowed to have their *own input* or responsibilities when working with the ICT tool, namely whether they are allowed to choose what to do and how to do it (e.g. Chisholm 1995; DeVoogd 1998; Maurer & Davidson 1999). As mentioned, especially girls prefer programs that allow for multiple paths and many possible answers (Agosto 2001). Many authors argue for designing programs that provide learners with flexibility (Ikegulu 1997). Henderson (1996) is of the opinion that variability and flexibility should be features of instructional ICT programs in order to position learners as active participants in the learning process. Both Gillani (2000) and Irwin *et al.* (1994)

see it as important for a culturally sensitive website to offer students the possibility to add their own information in order to construct their own knowledge. Maurer and Davidson (1999) emphasize the motivating role ICT can play in general by giving children the responsibility for their own learning process.

The following section presents a summary of our findings in the form of an index for identifying the characteristics of inclusive ICT applications. This is followed in by a discussion of the various – and sometimes contradictory – results of our literature review on gender, ethnic and SES differences related to ICT in primary and secondary education.

Index of inclusiveness

We have shown that gender inclusiveness and cultural sensitivity are generally defined as doing justice to the diversity of people in society and taking into account the diverse backgrounds of students, and have discussed the ways in which different groups of students may be excluded or alienated by characteristics of the ICT applications used. Our review included suggestions for the design and selection of more inclusive ICT programs. Below is a systematic summary of our research results in the form of an index for the gender inclusiveness and cultural sensitivity of ICT tools. The three main topics that appeared in the literature constitute the three main parts of the index, namely:

- the characteristics of an *inclusive content* of a technology-rich learning environment;
- the characteristics of an *inclusive visual and audio interface* of a technology-rich learning environment; and
- the characteristics of an *inclusive instructional structure* of a technology-rich learning environment (Table 1).

Discussion

In the course of our review, we encountered a number of questions and dilemmas associated with the idea of an index of inclusiveness for designing and selecting educational ICT tools. In this final section we present a summary of these questions and dilemmas by dividing them into two central issues and discussing each issue in more detail. We conclude by making some sug-

gestions for ways in which the index may be used in research and educational practice.

The first issue is whether a special index for the inclusiveness of ICT tools is necessary, as many of the issues addressed apply equally to other teaching materials. With regard to, for example, textbooks it has been argued that they are not equally accessible or attractive to different groups of students, because of their content factors, required learning strategies, etc. Moreover, checklists for more inclusive textbooks have already been made (e.g. Michel 1986). Notwithstanding these similarities, we think that ICT tools have a number of specific features that make a special index even more relevant to ICT-based materials than to other materials. First of all, educational ICT applications have a great impact on the learning processes through the combination of images, sounds, video and text. Second, using ICT applications usually changes the role of the teacher in the learning environment. ICT tools are often used as a means for students to work independently, which gives the teacher fewer opportunities to make supplementary remarks and to stimulate reflection. In a face-to-face learning situation, teachers have more possibilities to use material in a flexible manner, adding and skipping parts, or discussing information that is one-sided or biased. Moreover, in many ICT applications the course of the learning processes that students can follow is structured in a detailed way. Assumptions about the 'ideal' student and the 'ideal' learning process – the scripts in other words – are incorporated or built into the ICT tool more deeply than is the case with many other linear or written teaching materials.

The second issue is the diversity of experiences, preferences, opinions, etc. when different groups of students are taken into account. Is it possible – and desirable – to design ICT materials that fit in with the interests, backgrounds, learning strategies, etc. of all students? As stated in the introduction, we built on the educational perspective that learning processes are fostered most when students are actively engaged in activities that are meaningful to them and are appropriate to their level and learning approach. From this standpoint, some general principles can be distinguished, for example, the importance of authentic contexts, taking into account the initial level of the student, the benefits of collaboration and the importance of the good preparation and guidance of this

Table 1. Index of inclusiveness of educational tools

1. Content	
Perspective	
– Presence of different groups	Is there a balanced representation of diverse human groups (e.g. male/female; different cultural backgrounds, diversity of ethnicity/race; different social classes; urban/rural; diversity of religions/beliefs)
– Representation of groups	Are the groups presented in ways that are positive, equal and non-stereotypical (e.g. variety of living situations, variety of occupational tasks and other activities, variety in human responses, aggressive as well as sensitive, active as well as inactive)?
– Contributions of groups	Are the groups represented in ways that reflect accurately their potential contributions to the subject of the program Are issues relating to groups routinely included within the content as opposed to being separated out as 'special concerns'?
	Does the content avoid assuming that all people are operating from the same group, perspective and/or values?
	Is it clear that decisions made in simulations may have different effects for different groups?
Respectful of values	Is the content respectful and considerate of the values, manners and taboos of the different cultural groups?
	Is the language free of biased terminology?
Real-life context	Is the subject matter presented in an authentic context (e.g. by using the experiences of the students, actively involve the students in problem solving, addressing the usefulness of the subject in daily life, presenting a subject using different disciplines)?
Addressing different interests	Does the material have the potential to attract the interest of all groups, not just represents a stereotype of the interest of one group?
2. Interface	
Visual aspects	
– Presence and representation of different groups	Is there a balanced representation of diverse human groups (e.g. male/female; different cultural backgrounds, diversity of ethnicity/race; different social classes; urban/rural; diversity of religions/beliefs) Are the groups presented in ways that are positive, equal and non-stereotypical (e.g. variety of living situations, variety of occupational tasks and other activities, variety in human responses, aggressive as well as sensitive, active as well as inactive)?
– Respectful of values	Is the visual interface respectful and considerate of the values, manners and taboos of the different cultural groups (e.g. in the use of colour, icons, pictures of animals and other images)?
– Preferences of different groups	Are the preferences of different groups taken into account in the visual interface (e.g. bright vs dark colours, detailed or not, clarity of images)?
– Packaging	Do the packaging and/or advertising show a diversity of groups rather than one group to the exclusion of others?
Audio aspects	
– Voice	Does audio material include narrators from a range of group voices?
– Music and sounds	Does the sound track include a variety of styles of music/sounds?
3. Instructional structure	
Prior knowledge	
– Initial level	Is the material designed effectively and explained thoroughly enough so that all users can work with it, regardless of differences in ICT skills and knowledge Content knowledge and learning capabilities
– Home language	Does the material acknowledge that learners may have a variety of home languages and take that into account (e.g. by using dictionaries, the use of clear language, multilingual)?
Learning strategies	Does the material acknowledge that learners may have a variety of learning strategies and take that into account
Learning activities	
– Collaboration	Does the program accommodate learning together as opposed to competition? If working in groups is required does the program: Accommodate multiple roles and tasks

Table 1. Continued

– Communication	Provide all students with the opportunity to do different tasks and practice different roles Does the program accommodate ways of communication with other people, e.g. experts, students? If communication is required does the program: Acknowledge that some students may have difficulty with asking (why-) questions, arguing with adults or formulating their ideas? Acknowledge that differences in communication styles exist between different groups or different languages (e.g. differences may occur in frequency, length or tone of messages)?
– Skills	Are different kinds of skills addressed (e.g. writing, drawing)?
Help	
– Scaffolding	Does the program offer scaffolding support, i.e. an apprenticeship approach helping the student to develop the necessary skills?
– Feedback	Is the feedback to the student positive and direct?
– Self-esteem	Does the program offer support in a way that promotes the self-esteem of the student? Does the program offer ways for students to function as teacher or expert to other students?
Students input	
– Choice	Does the program offer possibilities for students to have choice in how to work (e.g. are there different ways to use the program, different solutions to the assignments) Is the student treated as an active participant with responsibility for their learning process?
– Flexibility	Is the program made in such a flexible manner that students can alter parts to their preference? Can students add their own information and experiences into the material

process. It is interesting to note that some of these general characteristics appear in educational theory and research as powerful principles of learning for all students (e.g. Dewey 1916; de Corte 2000), and at other times as principles of learning especially suited for girls and at-risk students.

However, following these general guiding principles, it might be advisable for different students to use different learning materials, namely materials that offer the most motivating, authentic context that fits in with the level and the learning strategy preferences of specific students or groups of students. From this perspective several authors indicate that it is not possible to design an ICT tool that will conform to all these different interests, levels and preferences (Ikegulu 1997; Upitis 1998; Gillani 2000). Designing material that is appreciated by students from all cultural backgrounds is perhaps an even more insuperable problem, as illustrated by the example of the boy who is about to meet his mother's boyfriend, and that of the use of the colour white. Although ICT tools have much more potential to meet students preferences compared with other learning materials, because of the possibility of using different settings from which students can choose, it is still impossible to implement

selection possibilities for all items mentioned above. We therefore adhere to the opinion that schools should be able to offer students a *variety* of ICT materials, in order to provide each student with interesting, motivating and meaningful ways of learning (e.g. DeVaney 1998; Upitis 1998). From this standpoint, inclusiveness relates to the *entire* collection of ICT tools in the classroom or school. As far as individual applications are concerned, teachers should at the very least be aware of the possible biases in and the sensitivities and preferences of different groups of students.

We think that the index we have developed can be useful as an equality tool in both educational practice and research. First of all, it can function as a guideline for educational software and web designers, helping them to make use of the phenomenon of scripts in educational ICT tools in a conscious and productive way. Similarly, it can support teachers in selecting ICT materials for their students, by allowing them to test ICT tools against the different themes and sub-themes and to make choices in accordance with the composition of their group of students. Therefore, teachers must be aware of their own preferences in the selection of software (Upitis 1998). By presenting their students with only a narrow range of tools (e.g.

only science-oriented software, based on their own preference for science), teachers will contribute to the non-inclusiveness of ICT use. The index can play a role in this selection process. Many authors suggest that involving members of different social groups in the evaluation and selection of programs (Irwin *et al.* 1994; Henderson 1996; Reeves 1997; Adler 1999; McLoughlin 1999) is an effective way of enhancing inclusiveness.

In empirical research, the index can be a useful instrument for establishing whether and, if so, to what extent different characteristics of ICT tools (i.e. the scripts built into them) actually promote or inhibit learning for different groups of students. However, in order to carry out this kind of research it will be necessary to operationalize the index in such a way that it can function as a measure of the inclusiveness of specific tools. This will require translating the index into an instrument with scores, possibly different scores for SES/ethnicity/gender on the first two parts of the index (content and interface). Because this index is based on studies of many different kinds of ICT applications, it is sometimes rather general. In the light of specific research goals it might be necessary to differentiate between the different types of applications.

Finally, the index concerns only the ICT material itself and does not take into account the context in which it is used. The learning context was mentioned in various parts of this article. The context in which and the way educational materials are used appear to be crucial to the learning experiences of students. Schofield (1995) shows that while the use of ICT influences the classroom culture, the classroom culture influences the use of ICT. It is therefore very important to look at ICT applications not only from a static point of view but also while they are in actual use. The learning environment, as students experience it, comprises the ICT tool, the teacher and his or her teaching and the interactions in the class. The scripts that are built into educational ICT tools appear in different forms in the other curriculum levels as well. The role of the teacher in learning with ICT is emphasized by many authors. A 'can do' attitude (i.e. high expectations) towards students is seen as essential (Milone & Salpeter 1996). It is the teacher's task to challenge the students and to motivate and involve them in the learning process. Based on a case study of

a multicultural, multigrade class (grades 1–3), Chisholm (1995) argues that effective computer use in multicultural classrooms requires the teacher to use computer management and instructional strategies that include supporting the cultural and individual learning preferences, flexibility in classroom seating, student mobility, student grouping and giving students options and autonomy. Future research into the inclusiveness of specific ICT tools must include the context in which these tools are used.

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