doi: 10.1111/j.1365-2729.2010.00374.x

ICT use in education: different uptake and practice in Hebrew-speaking and Arabic-speaking schools in Israel

R. Nachmias, D. Mioduser & A. Forkosh-Baruch

Tel Aviv University, Israel

Abstract Closing educational gaps between sub-populations in Israel, particularly between students in Hebrew-speaking and Arabic-speaking schools, persists to be one of the priorities of Israel's education system. In the field of information and communication technology (ICT), this goal refers to infrastructure as well as practice, i.e. teaching and learning. A secondary analysis of Second Information Technology in Education Study 2006 study findings portrays a multifaceted state of affairs on some issues, e.g. vision and goals, attitudes on ICT importance in general and as a lever for paradigmatic change in particular. This is contrary to expectations due to the inequality in allocation (mainly of infrastructure) between the two sectors. Arabic-speaking mathematics teachers indicate greater ICT usage in their target class, while among science teachers, Hebrew-speaking teachers report greater usage and influence on their pedagogy, indicating innovative usage**.** Conclusions suggest that further effort is needed to close the gaps between Hebrew- and Arabic-speaking schools as well as collaboration and exchange of ideas, information and educational experience between staff members from both sectors.

Keywords Arabic-speaking schools, education, Hebrew-speaking schools, ICT, implementation.

Introduction

Closing gaps between sub-populations in Israel, particularly between students in Hebrew-speaking and Arabic-speaking schools, is one of the priorities of Israel's education system. Regarding information and communication technologies (ICT), this goal refers to infrastructure as well as practice. Assumptions based on general perceptions of educators and policymakers as well as on annual statistic data published by the Central Bureau of Statistics (http://www.cbs.gov.il) indicate disparities in ICT implementation between Hebrew- and Arab-speaking schools. Data collected in the Second Information Technology in Education Study (SITES 2006) study offer a unique opportunity to examine these assumptions.

Accepted: 5 May 2010
Correspondence: Rafi Nachmias, Tel Aviv University, School of Education Ramat Aviv, Tel-Aviv, Israel, 69978. Email: nachmias@post.tau.ac.il

The secondary analysis of SITES 2006 data presented in this paper addresses the comparison between Hebrew- and Arab-speaking schools concerning policy and goals for ICT usage, infrastructure, staff support and encouragement in ICT use for teaching, innovative ICT usage patterns by teachers and perceived ICT-related obstacles hindering schools' capacity to realize their pedagogical goals. Hence, we address two main research questions: what are the similarities and differences in ICT implementation between Hebrew- and Arab-speaking schools and what factors contribute to the differences between the two sub-populations?

Background

This paper reports on a specific case, i.e. ICT perception and actual implementation in Hebrew- and Arab-speaking schools in Israel. However, this specific case has been analysed within the perspective of a wider

framework encompassing countless examples of differential and, at times, conflictive, ICT integration processes into education systems by countries and even by population groups within countries. In this brief account of the conceptual framework for our study, we will survey its different layers, from general considerations to the instantiation of these in the Israeli school system concerning the two sub-populations. We will first discuss briefly the reconsideration of the definitions of the 'digital' divide phenomenon, then we will focus on what we claim are key factors for explaining the study's data, i.e. cultural and socio/economical factors, and finally, we will refer to specific aspects of the Israeli school system in Hebrew- and Arab-speaking schools.

Reconsidering the 'digital divide' phenomenon – socio/cultural factors

This study can be viewed as part of a wider research agenda aiming to understand the complex process by which ICT is integrated in educational systems, in light of the enormous differences not only in terms of success and failure, but more importantly, in terms of the particulars of the process itself in different countries and by different populations within countries.

It is suggested in the literature that the term commonly in use for referring to these differences, 'digital divide', does not capture the complexity of the phenomenon (Warschauer 2002). Commonly, it refers to the difference between 'haves' and 'have-nots', obscuring the important social, economic and political factors that frame if and how technology is adopted and used. Immediate corollary of the simplistic approach is the belief that supplying computers and infrastructure (that is transforming 'have-nots' into 'haves' of appropriate hardware and communication facilities) will lead to the elimination of the divide and the incorporation of the 'recently equipped' to the global ICT community.

The current approach is to redefine the divide in terms of 'digital inequality' (Kvasny 2006) considering, beyond the mere access to hardware, the implications of equitable access to the benefits (cultural, social, economical, educational) of the digital technologies. In this sense, it is important to recognize not only the need to facilitate physical access to artefacts but also the complex array of factors characterizing the particular population expected to adopt these technologies. Among these factors are the population perceived needs, culture, believes, traditions, values, personal and institutional roles, perception of goals important to be achieved and perception of the way all these interplay with global trends within and beyond their countries (Bourdieu 1993; Pinkett 2000; Kvasny 2006).

The research literature on the adoption of ICT in general, and into educational systems in particular, reports on the various forms this process takes place in different countries and societies. An obvious account on contrasting realities could be expected while looking at developing countries (e.g. Loch *et al.* 2003; Albirini 2006). However, interesting reports relate to the situation within areas located at the front of the innovative forces leading the development and implementation of the new technologies, e.g. Europe (e.g. Maier-Rabler 2002) and the USA (e.g. Bissel 2004). Maier-Rabler's account analyses interesting differences in European countries' perception of ICT and its role by geographical categorization in clusters (e.g. Nordic, Mediterranean, Anglo-American, etc.). In these clusters, the defining characteristics are related to socio-historical, cultural and even religious aspects affecting social organization and ways of life as well as the ways ICT adoption is conceived. Her analyses led to the definition of a continuum with the poles 'information friendly' versus 'information restrictive' within which information cultures are located. In some cases, historically rooted socio-political as well as ethnic factors are reported as leading to inequalities between sub-populations' educational systems as in the case of Cyprus (Trimikliniotis 2004).

In the USA, interesting accounts of the adoption process of ICT by Native Americans living in reserves were reported (Bissel 2004). On one hand, a clear claim is made on the potential role of ICT for solving profound inequalities affecting this population's economical, cultural and educational life. On the other hand, it is equally clear that any solution should take in account this population's unique aspirations and characteristics:

> steps to narrow the digital divide must be balanced with the history and grand traditions of Native Americans. It is important to look at the desire of many Native Americans to live on reservations and within tribal communities in order to understand the lack of technological development on Native American reservations' . . . '[m]any of them felt bringing computers would take children's interest away from their community traditions and families and would expose them to bad things.' There is concern that technological processes of assimilation will dominate and thus be an effective way of homogenizing

> Native American communities. In general, there is a feeling that if Native American nations try to adopt Western or American institutions they will be unsuccessful in Native communities (Bissel 2004, pp. 142–143).

Similar to Europe and the USA, similar aspects and characteristics of ICT adoption processes are described for countries in the Arab world, such as the cases of Syria (Albirini 2006) or Egypt (Warschauer 2003).

Referring specifically to educational systems and educators, it becomes clear that teachers' reactions to technological innovations are mediated by their cultural perceptions, norms and values, and school regularities and practices as well (Chen *et al.* 1999; Loch *et al.* 2003). Examining educators' (teachers, principals, decision-makers) cultural perceptions is particularly important for countries or sub-populations in which ICT is not yet an integral part of their culture. Because of the innovative character of ICT, the study of factors likely to affect its encounter with established norms and behaviours is of crucial importance (Albirini 2006). At the same time, it is equally clear that the definition of policies, the devise of action plans, the allocation of resources and the actual actions taken should take place in overtly congruency with the population's perceptions of needs, values and norms.

The integration of the aforementioned approaches in the conceptual framework underlying our study led us to focus on two main dimensions of potential conflict: the first, internal to the target population and the second being the interaction between the population and its external environment.

The first dimension focuses on the population's (i.e. educators) conflict between innovation and preservation, between the understanding of the need to become part of the changing world and the desire to preserve social and cultural identities and values and between the understanding of the potential benefits – e.g. educational, economical, social mobility – as well as potential damages inherent to the adoption of ICT.

The second dimension relates to the interaction between the population's needs, claims and requested solutions and the way the general social and formal institutions (administrations, ministries, decision-making agents, the general public) relate to these. This conflict can be normally recognized by examining the gaps between declared intentions, legislation and decisions made, and the actual implementation (or lack of implementation) of these decisions and policies. It is evident that these gaps also are affected by underlying currents of social, political, cultural and economical nature affecting the interaction between a sub-population and the formal institutions, between societies or between countries at different levels of development.

For the specific instantiation of these dimensions within the context of the school systems examined in our study, the next section presents their actual characteristics as part of the Israeli educational system.

Hebrew- and Arab-speaking schools – policies and practice

Israel's education system reveals cultural and ethnic diversity: About 20% of students from kindergarten to high school belong to the Arab, Bedouin and Druze minorities (i.e. the Arab sector) and about 20% attend Jewish orthodox schools. Just over 15% are newcomers who have immigrated to Israel in the last decade. The Arab and Jewish sectors each have their own supervisors. Table 1 presents the distribution of students according to the two main sectors, Jewish and Arab, divided into age groups (Ministry of Education 2007).

Closing gaps between Hebrew- and Arabic-speaking populations is a constant issue addressed by the national education system (Compulsory Education Act of 1949) as well as equal educational opportunities (State Education Act of 1953). This policy had not brought about the expected outcomes of equality and equity. Large gaps in educational inputs as well as in student outcomes between different subgroups in the Israeli society have been evident, associated with several variables, e.g. socio-economic status, ethnic origin (among Jewish population), school location (urban–rural, centre–peripheral) and also sectors (i.e. Hebrew-speaking vs. Arabic-speaking population) (Shavit, 1990).

Table 1. Number of students in Israel, by sectors: Jewish sector and Arab sector (in thousands of students) for the school year 2006–2007 [Source: Israeli Ministry of Education, 2008].

	Total	Jewish sector	Arab sector
Public kindergartens	342	258	84
Elementary schools	821	595	226
Lower secondary schools	258	188	70
Higher secondary schools	352	281	71
Of these, 12th graders	102	82	20
Total	2073	1616	457

Recommendations for improvement of the educational system in the Arab sectors (1981, 1985, mentioned in Rivlin-Zor & Zoabi 2005) led to the announcement of two five-year plans for the Arabic-speaking sector, one beginning in the early 1990s and the second launched in 1999, resulting in several improvements (Zuzovsky 2008).

The action plans aimed to improve all aspects of the education milieu: matriculation ratio, drop-out ratio; adding study hours; increasing staff; enhancing science and technology education; promoting special education services and professional support; and infrastructure, e.g. construction and improvement of the school buildings and surroundings. These actions resulted in numerous improvements within the Arab education system.

Although the curriculum for both sectors is a similar one, especially in subject matter such as mathematics and science, the Arab education system is largely a traditional one (Nachmias *et al.* 2008), influenced by many social and political events since the establishment of Israel. The system is affected by severe problems as a result of neglect, discrimination, lack of involvement within the Arabic-speaking population and inferiority in terms of educational infrastructure and resources (Lavi 1997; Sprinzak *et al.* 2003). Notwithstanding, Arab teachers were considered throughout the years an important component of the intellectual elite within the Arab population. Still, during the 1950s–1970s, most Arab teachers were uncertified; during recent years, level of teacher qualification has rapidly grown (Israeli Central Bureau of Statistics 2008).

More than ever, the public education system is being called on to close the gap between both populations. The recent National Task Force for the Advancement of Education (the 'Dovrat Committee'), specifically addresses this discrimination in its recommendations, i.e. equal budgeting of Jewish and Arab education-based on uniform, differential per student funding. According to recommendations, disparities between Hebrew-speaking and Arabic-speaking schools should be eradicated, thereby reducing differences in educational processes, achievements and conditions, including percentages of students graduating high school and percentages of students eligible for matriculation certificates (Dovrat Committee – Task Force for the Advancement of Education in Israel 2005).

ICT in the Israeli school system

By the 1990s, efforts to implement ICT nationwide in schools became more systematic, beginning with hardware and infrastructure, later focusing on implementing ICT-related pedagogical practices, and further facilitating ICT implementation in teaching and learning as well as teacher training.

Computers were introduced in the Arabic-speaking sector a decade later than in the Hebrew-speaking sector. Curricula were translated into Arabic and used in schools at the beginning of the 1990s, and a new curriculum was developed in the field of computer literacy. Nevertheless, there is still shortage in ICT materials in the Arabic language in spite of national and local efforts, and for this matter, the Internet could play a central role as a means for facilitating ICT usage for pedagogical purposes. Notwithstanding, according to the SITES 2006 findings, the student/computer ratio calculated for the schools participating in the study showed great disparities, according to which there are almost twice as many students per computer in the Arabic-speaking sector than in the Hebrew-speaking sector: approximately 1: 21 as opposed to 1: 11.1, respectively. Data dealing with Internet connectivity are even more troubling (Nachmias *et al.* 2009). Still, within Arab-speaking municipalities, there are some in which the student/computer ratio is high and some in which this ratio is relatively low. Table 2 displays examples of Arab settlements that are included among the 10 municipalities with the highest and 10 municipalities with the lowest student/computer ratio altogether.

ICT resources available to Hebrew-speaking schools and Arab-speaking schools are generally similar since the 'National Computerization Program' does not discriminate between schools based on ethnicity. However, former general socio-economic discrimination between the two sectors since the establishment of the state of Israel has long-term implications regarding ICT implementation patterns within the schools. Consequently, the gap still exists, not in the type of ICT packages (e.g. equipment, infrastructure software) but rather in quantities (Nachmias *et al.* 2009).

In light of the aforementioned, a crucial question concerning the data collected in the International Association for the Evaluation of Educational Achievement (IEA) SITES 2006 study is that of similarities and differences between Hebrew-speaking and Arabic-speaking

Table 2. Local Arab municipalities included in the list of the 10 Israeli municipalities with the highest and lowest student–computer ratios [Knesset Research and Information Center, 2008].

	Municipality	No. of schools	N. of students	No. of computers	Student: computer ratio
Highest ratios	Abu-Gosh	3	1576	21	1:75
	Tayibe	15	9278	261	1:36
	Abu-Basma	20	10 326	291	1:36
	Nahf	5	3083	90	1:34
	Tira	13	5796	191	1:30
Lowest ratios	Beit-Jan	5	2661	550	1:5
	Ha'jar	2	571	105	1:5
	Masaa'de	3	1081	198	1:6

schools in perceiving and applying pedagogical practices using ICT. As stated in the introduction, the issues addressed in this study referred to differences between Hebrew- and Arab-speaking schools concerning policy and goals for ICT usage, infrastructure, staff support and encouragement in ICT use for teaching, ICT usage patterns by teachers and perceived ICT-related obstacles hindering schools' capacity to realize pedagogical goals.

Method

The current study was based on a secondary analysis of the data from the SITES 2006 international study, examining ICT implementation in lower secondary schools in general, and in eighth-grade classes in particular, using questionnaires for school principals ($N = 380$), ICT coordinators ($N = 380$) and eighth-grade science and mathematics teachers ($N = 2038$).

The focus of SITES 2006 is on the teaching and learning process. Contextual factors are perceived as conditional and explanatory with regard to possible variations observed between schools with regard to these mentioned processes. These conditions are, in fact, indicators of the readiness of schools and teachers to implement ICT in novel pedagogical practices.

The framework visualizes that teaching and learning at the classroom level and the use of ICT in the classroom is influenced by factors on the school and teacher levels, which in turn are influenced by school external factors (policies, community, parents, etc.).

SITES 2006 was designed as a survey, focusing on the overall situation of ICT implementation in pedagogical practices on the eighth-grade level as defined by the International Consortium (for details, see Law *et al.* 2008). Hence, three questionnaires were constructed: a principal questionnaire, a questionnaire for the ICT coordinator and a teacher questionnaire for mathematics and science teachers of eighth-grade students; all these were defined and constructed internationally. The questions addressed issues of ICT policy and practice, attitudes and ICT skills of teachers and students. The questions included items to be rated on a Likert scale commonly used in surveys. In most items, respondents were requested to grade their responses on a four-scale continuum; some items required a *yes/no* reply, while in other items requiring reports of change, the scale was a five-point one, the middle value being *no impact* or *no change*.

The questionnaires were translated and adapted to the Israeli culture from English to Hebrew only since all teachers in the Arab sector speak Hebrew, all teachers would receive identical questionnaires in terms of language as well and the cost–benefit considerations were in favour of one translation only.

Data were collected in the year 2006. The questionnaires included different sets for each position holder: teachers (mathematics and science teachers received similar questionnaires), principal and technical coordinator. In the Israeli report, in concurrence with the structure of the international report, data extracted from the three questionnaires were compared between the Hebrew- and Arabic-speaking sectors.

Data were compared regarding several aspects of ICT implementation in schools between the two sectors, comparing means of ratings and responses of principals, ICT coordinators and teachers. Effect size used – r – was calculated for identifying the proportion of variance explained by the data in congruence with Cohen's benchmarks, portraying general definitions for small,

medium and large effect sizes (i.e. small size effect $r = 0.10–0.30$, medium size effect $r = 0.30–0.50$ and large size effect $r = 0.50$ or beyond). The goal was to achieve further understanding about differences between the two main sectors in the Israeli education system and to use the conclusions to formulate policies aiming to narrow the gaps between the two sub-populations.

Results

The results presented herewith are related to questions posed in the main study. Tables present statistics of relevant variables for the entire sample that served the analyses as well as for the Hebrew-speaking and Arabic-speaking groups.

Policy and goals for ICT implementation

In general, principals in Israel considered ICT implementation in their schools to be important compared with the results of the international data. Table 3 details items for the question: *For each of the following, how important is the use of ICT at Grade 8 in your school?* When comparing the Hebrew- and Arabic-speaking sectors on these items, there are differences in the level of importance attributed by principals to each item with relation to ICT usage in the eighth grade. It seems that in a number of domains, principals in the Arab-speaking sector see greater importance to ICT usage than their Hebrew-speaking colleagues as displayed in Table 3.

The items that were rated significantly higher among principals in the Arab sector were: 'fostering collaborative and organizational skills when working in teams' and 'increasing learning motivation and make learning more interesting' as well as 'acting as a catalyst in changing the pedagogical approaches of teachers' and 'preparing students for the world of work'. The latter items entail notions of meaningful usage of ICT as a lever for current innovative teaching as well as future expectations for coping with an ICT saturated workplace. As for the item concerning 'satisfying parents' and the community's expectations', this is indeed considered of great importance, especially in the Arab sector, in which society is relatively traditional. As for effect size, with regard to measures in education, this needs to be dealt with caution since at times, a small and inexpensive change could make a vast difference by an effect size of even as small as 0.1. Hence, there could be a very significant positive change in attitudes as well as infrastructure and ICT implementation de facto as a result of systemic actions and even more so if the effect was growing over time had this been measured. The inclusion of social considerations in light of the characteristics of the community is regarded therefore as an

Table 3. Average ratings of Israeli principals concerning the importance of ICT usage for achieving a list of targets, according to sectors (SD in brackets).

Items	Sectors		Effect size *r*
	Hebrew-speaking (*N* = 221)	Arabic-speaking (*N* = 73)	
To prepare students for the world of work	3.31 (0.87)	3.51 (0.63)	0.011*
To improve students' performance on assessments/examinations	3.27 (0.78)	3.44 (0.60)	0.010
To promote active learning strategies	3.48 (0.71)	3.49 (0.58)	0.000
To individualize student learning experiences in order to address different learning needs	3.42 (0.73)	3.41 (0.72)	0.000
To foster collaborative and organizational skills when working in teams	3.22 (0.80)	3.49 (0.63)	0.023**
To develop students' independence and responsibility for their own learning	3.47 (0.69)	3.60 (0.57)	0.007
To do exercises to practice skills and procedures	3.52 (0.67)	3.45 (0.62)	0.002
To increase learning motivation and make learning more interesting	3.58 (0.62)	3.75 (0.50)	0.015*
To satisfy parents' and the community's expectations	2.99 (0.79)	3.32 (0.75)	0.032**
To act as a catalyst in changing the pedagogical approaches of teachers	3.30 (0.76)	3.60 (0.55)	0.033**

*Significance level ≤ 0.05; **significance level ≤ 0.01.

important step towards meaningful and successful ICT implementation.

ICT infrastructure

The issue of infrastructure, while being identified with the more technical aspects of ICT in schools, is of huge importance. Therefore, information extracted from the principal questionnaire may provide substantial information regarding priorities of schools on these issues; this information is of great value for policymakers in the Ministry of Education. Table 4 portrays Israeli principals' priorities regarding ICT infrastructure. Principals were asked about the priority level they give to resource allocation in their school for enhancing the use of ICT in teaching and learning for eighth-grade students in their school. We measured principals' attitudes concerning resource allocation by sectors: Hebrew-speaking vs. Arabic-speaking schools, in light of the ongoing gap in ICT infrastructure.

Findings in Israel indicate, in general, high priority for each of the five items, although the last item on the list was considered relatively less of a priority. Notwithstanding, differences are significant with higher marks for the Arab-speaking schools in four of the five items.

The goal of decreasing the number of students per computer especially engages principals in the Arab sector – this probably being the expected result of the existing gap between the two sectors. Still, principals in the Arab sector are not satisfied only with increasing the number of computers within their schools. They explicitly give priority – compared with their peers in the Hebrew-speaking sector – to ICT pedagogical implementation by striving to increase digital learning resources related to the school curriculum and to establish online learning support platforms to enhance ubiquitous learning and learning management. Hence, though when listing the priorities one sees a similar pattern in both the Arab- and Hebrew-speaking sectors, differences in rated levels of priority are significant and in favour of the Arab-speaking sector.

Support and encouragement of teacher's implementation of ICT

Principals were asked to indicate to what extent the school's leading staff encourages ICT usage for a number of activities on a four-point Likert scale. Items mostly dealt with collaboration and communication among students, as well as real-life experiences, thereby reflecting school visions and goals. We performed a comparison between the Hebrew- and Arabic-speaking sectors on principals' responses to these items shown in Table 5.

Results show that principals not only attribute great importance to encouragement of school staff to use ICT but are also relatively confident that their leading staff members encourage, *de facto*, ICT usage among staff members. Significant difference between the Hebrew- and Arabic-speaking sectors was found in all the items, all in favour of the Arabic sector. These findings were against all expectations. Hence, in terms of encourage-

Table 4. Average ratings of Israeli principals' responses concerning priorities regarding ICT infrastructure, by sectors (SD in brackets).

Items	Sectors		Effect size *r*
	Hebrew-speaking (*N* = 215)	Arabic-speaking (*N* = 71)	
To decrease the number of students per computer	3.34 (0.910	3.66 (0.63)	0.26*
To increase the number of computers connected to the Internet	3.60 (0.82)	3.76 (0.57)	0.008**
To increase the bandwidth for Internet access of the computers connected to the Internet	3.36 (0.91)	3.42 (0.75)	0.001
To increase the range of digital learning resources related to the school curriculum	3.29 (0.85)	3.58 (0.67)	0.023*
To establish/enhance an online learning support platform and its management so that teaching and learning can take place any time, anywhere	2.96 (0.92)	3.29 (0.79)	0.026*

*Significance level ≤ 0.01; **significance level ≤ 0.05.

Table 5. Average ratings of Israeli principals' responses concerning the extent to which the school's leading staff encourages teachers to use ICT for a number of activities, by sectors (SD in brackets).

Items	Sectors		Effect size *r*
	Hebrew-speaking (*N* = 221)	Arabic-speaking (*N* = 73)	
Organize, monitor and support team building and collaboration among students	2.97 (0.73)	3.48 (0.50)	0.095*
Organize and/or mediate communication between students and experts/external mentors	2.75 (0.80)	3.15 (0.82)	0.044*
Facilitate collaboration (within or outside of school) on student activities	3.14 (0.70)	3.52 (0.63)	0.055*
Collaborate with parents/guardians/ caretakers in supporting/monitoring students' learning and/or in providing counselling	2.63 (0.85)	3.12 (0.76)	0.062*
Provide students with experiences that show them how certain activities are performed in real life or by experts	3.08 (0.77)	3.36 (0.68)	0.026*

*Significance level ≤ 0.01.

ment of teachers, Arab-speaking schools have a noticeable advantage over Hebrew-speaking schools. Despite support of leading staff that both sectors provide for teachers, encouragement given to collaboration within school and between school members and factors outside the school is especially evident in the Arab sector. One explanation for these differences is the striving for progress within the Arab sector in spite of inferior infrastructure conditions and a more traditional education system in comparison with the Hebrew-speaking sector.

A crucial and relevant question presented to the principals referred to support for staff development: the extent to which eighth-grade mathematics and science teachers are required or encouraged to acquire ICT knowledge and skills. The issues examined were the following: do leading staff members encourage teachers to acquire ICT-related knowledge and skills for facilitating innovative pedagogical processes?; and are these accessible to teachers? When comparing the Hebrew-speaking and Arabic-speaking schools on these issues, intriguing data arose from the principals' responses, according to which in all items, requirement and/or encouragement was higher in Arabic-speaking schools as presented in Table 6.

This significant difference in all items may be explained via a number of factors. First, as mentioned in the previous sections, cultural differences shed light on several disparities between these two societies, the Hebrew-speaking and the Arabic-speaking subgroups. In the Arabic sector, the possibility to pose demands on teachers is much easier since as a relatively conservative society, it is more customary to follow the principal's orders on these issues. Secondly, because of a feeling of discrimination and the awareness of gaps between both sectors, the notion among Arab principals is that teacher training on these ICT-related issues is essential for advancing education in Arab-speaking schools (Khattab 2003; Flum & Cinamon 2006).

ICT actual usage by math and science teachers

The teachers were asked to fill a question regarding ICT implementation in their pedagogical practice. The percentages of Israeli teachers reporting ICT implementation in their classes (i.e. ICT usage at least one time during the school year) was surprisingly low altogether: about 22% of the mathematics teachers reported using ICT in their class, and about 53% of the science teachers reported using ICT in their class. Also, the difference between the mathematics and science teachers was quite outstanding. Here, the examination of this figure for each sector apart is presented in Table 7, displaying an interesting pattern of usage.

The apparent conclusion from these data is that ICT usage is twice as much among the mathematics teachers in the Arabic-speaking sector than among their peers in the Hebrew-speaking sector (about 31% as opposed to less than 20%, relatively), although in both sectors, it is not the majority of teachers. This is quite surprising in light of the results earlier mentioned that concern ICT infrastructure being highly in favour of the Hebrew-speaking sector and exhibiting a large gap between the

Table 6. Average ratings of Israeli principals' reporting requirements and/or encouragement of acquiring ICT-related knowledge and skills, by sectors (SD in brackets).

Items	Sectors		Effect size *r*
	Hebrew-speaking (*N* = 209)	Arabic-speaking (*N* = 68)	
Integrating Web-based learning in their instructional practice	1.96 (0.56)	2.35 (0.54)	0.083*
Using new ways of assessment (portfolios, peer reviews, etc.)	2.05 (0.61)	2.28 (0.62)	0.026*
Developing real-life assignments for students	2.08 (0.57)	2.34 (0.56)	0.038*
Using real-life assignments developed by others	1.95 (0.56)	2.23 (0.55)	0.045*
Using computers for monitoring student progress	2.00 (0.71)	2.29 (0.60)	0.032*
Organizing forms of team teaching	2.02 (0.65)	2.30 (0.58)	0.037*
Collaborating with other teachers via ICT	1.87 (0.61)	2.14 (0.62)	0.036*
Communicating with parents via ICT	1.40 (0.56)	1.68 (0.72)	0.039*
Being knowledgeable about the pedagogical issues of integrating ICT into teaching and learning	2.13 (0.63)	2.34 (0.56)	0.020**
Using subject-specific learning software (e.g. tutorials, simulation)	2.02 (0.64)	2.22 (0.60)	0.018**

*Significance level ≤ 0.01; **significance level ≤ 0.05.

two sectors. In contrast, among the science teachers, more belonging to the Hebrew-speaking sector use ICT compared with the Arabic-speaking sector (about 55% as opposed to about 46%, relatively).

Some insight concerning the relatively low usage of ICT may be extracted from the teachers' reports on obstacles hindering their usage of ICT in teaching and learning. Twelve obstacles were presented to teachers, divided into three categories: school factors (school culture, resources), teacher factors (skills, self-confidence, time) and student factors (ICT skills, accessibility to ICT outside schools). Tables 8 and 9 present comparative data between the Hebrew-speaking and the Arabic-speaking teacher samples regarding these obstacles. Table 8 presents comparative data for the mathematics teachers, while Table 9 displays data for the science teachers.

The rows marked in grey indicate items for which the percents of reported obstacles were higher among the Hebrew-speaking mathematics teachers. The white rows indicate items in which the percents of reported obstacles were higher among the Arabic-speaking mathematics teachers. In mathematics, teacher-related obstacles were reported more by the teachers in the Hebrew-speaking sector than in the Arabic-speaking sector. In contrast, school- and student-related obstacles were reported more by the teachers in the Arabic-speaking sector. This may indicate that higher percents of mathematics teachers in the Arab sector feel confident with their ICT-related skills and ICT-related

Table 7. Percentages of Israeli mathematics and science teachers indicating ICT implementation in their class, by sectors.

Sectors	Mathematics teachers		Total	Science teachers		Total
	Hebrew-speaking (*N* = 658)	Arabic-speaking (*N* = 199)	*N* = 857	Hebrew-speaking (*N* = 532)	Arabic-speaking (*N* = 184)	*N* = 716
Percentage of ICT usage in teaching and learning activities (%)	67.2	32.8	100	77.7	22.3	100
Percentage of ICT usage in teaching and learning activities *from the total teachers of the sector* (%)	19	30.7	21.7 (of all Israeli math teachers)	54.9	45.7	52.5 (of all Israeli science teachers

Table 8. Percentages of Israeli mathematics teachers' responses concerning obstacles when implementing ICT in their teaching – total responses and by sectors.

	Mathematics teachers	Sectors (%)		Total (%)
		Hebrew-speaking (N = 630)	Arabic-speaking (N = 193)	
School-related	ICT is not considered to be useful in my school.	33.1	44.6	35.8
	My school does not have the required ICT infrastructure.	29.6	47.9	33.9
	My school lacks digital learning resources.	44.3	61.3	48.4
	I do not have the flexibility to make my own decisions when planning lessons with ICT.	27.1	31.3	28
	I do not have access to ICT outside of the school.	19.6	30.2	22
Teacher-related	I do not have the required ICT-related skills.	34.7	25.8	32.6
	I do not have the necessary ICT-related pedagogical skills.	35.1	31.1	34.3
	I do not have sufficient confidence to try new approaches alone.	27.8	13.8	24.5
	I do not have the time necessary to develop and implement the activities.	53.6	40.7	50.5
	I do not know how to identify which ICT tools will be useful.	33%	29.9	32.3
Student-related	My students do not possess the required ICT skills.	25.4	45.8	30.3
	My students do not have access to the required ICT tools outside of the school premises.	23.6	46.9	29.1

Table 9. Percentages of Israeli science teachers' responses concerning obstacles when implementing ICT in their teaching – total responses and by sectors.

	Science teachers	Sectors (%)		Total (%)
		Hebrew-speaking (N = 512)	Arabic-speaking (N = 186)	
School-related	ICT is not considered to be useful in my school.	24.1	41.9	28.8
	My school does not have the required ICT infrastructure.	29.8	45.2	33.9
	My school lacks digital learning resources.	47.7	61	51.3
	I do not have the flexibility to make my own decisions when planning lessons with ICT.	18.4	27.6	20.8
	I do not have access to ICT outside of the school.	15.6	29.3	19.2
Teacher-related	I do not have the required ICT-related skills.	23.7	31	25.6
	I do not have the necessary ICT-related pedagogical skills.	20.3	27	22.1
	I do not have sufficient confidence to try new approaches alone.	22	19.8	21.4
	I do not have the time necessary to develop and implement the activities.	51	39.2	47.9
	I do not know how to identify which ICT tools will be useful.	21.1	30.5	23.6
Student-related	My students do not possess the required ICT skills.	22.9	46.2	29.2
	My students do not have access to the required ICT tools outside of the school premises.	25.6	43	30.3

pedagogical skills in trying new approaches, in allocating time to develop and implement activities and in applying ICT tools for teaching and learning.

When comparing these figures of the mathematics teachers to figures of the science teachers, a slightly different picture is portrayed, although the direction of the data is similar. Table 9 herewith presents data reported by science teachers.

An examination of the obstacles encountered by the science teachers by sector shows that for most items, a

higher percentage of Arab-speaking teachers reported these as difficulties. Gaps are especially salient in school-related and student-related items. Again, as with the mathematics teachers, in teacher-related items, the gaps are smaller. Furthermore, in two items, relating to insufficient confidence to try new approaches and insufficient time necessary to develop and implement the activities, more teachers in the Hebrew-speaking sector reported difficulties than in the Arab-speaking sector (the rows marked in grey). Again, this indicates that the perceived source of obstacles in the Arab sector is, to a lesser degree, the teachers' rather than school and student aspects.

ICT-related obstacles affecting the overall attainment of pedagogical goals

Complementing the teachers' perceptions of obstacles affecting the fulfilment of subject-specific pedagogical goals, we examined the ICT coordinators' perceptions of obstacles hindering the attainment of general pedagogical goals. The ICT coordinators were asked about the extent to which ICT-related obstacles and non-ICT-related obstacles pose impediments in fulfilling the school's pedagogical goals. In general, all of the ICT coordinators considered the pressure to score highly on standardized tests a strong impediment; also, highly-rated obstacles were insufficient ICT equipment for instruction, for laboratories and insufficient digital educational resources for instruction. The intriguing data lie in the comparison between sectors as displayed herewith in Table 10, which presents the items that were significantly different between the ICT coordinators' responses by sectors concerning obstacles hindering the realization of pedagogical goals within Israeli schools.

The fact that in only three out of the 15 obstacles significant difference was found indicates that in general, there is a similarity between the ICT coordinators in Hebrew-speaking and Arab-speaking schools in their assessment of factors hampering the fulfilment of pedagogical goals within their schools. However, the three obstacles in which differences were found did not have similar orientation. In the first two obstacles, concentrating on ICT infrastructure (computers, Internet connection, ICT equipment for instruction), the Arab schools' average ratings were higher: 2.83 (compared with 2.45 in the Hebrew-speaking schools) and 3.27 (compared with 2.89). Notwithstanding, the direction is reversed when referring to ICT skills: it seems that while in Hebrew-speaking schools, the ICT coordinators considered teachers' lack of ICT skills as the highest rated obstacles among the three obstacles significantly different; in the Arabic sector, these were rated significantly lower. Hence, the situation portrayed by these data highlights the notion according to which technical issues are those that pose the greatest obstacles in successful ICT implementation in the Arab-speaking sector, while the human factor is the salient obstacle in realizing schools' pedagogical goals in the Hebrew-speaking sector, according to the ICT coordinators.

However, when posing the same question to the school principals, a greater gap was revealed between the sectors, and surprisingly, different ratings were given. In contrast to the ICT coordinators' responses, in which 12 out of the 15 items there were non-significant differences, in the principals' responses, there were significant differences in nine of the 15 items. Table 11 presents the principals' views on the extent to which ICT- and non-ICT-related obstacles pose impediments

Table 10. Average ratings of Israeli ICT coordinators' responses concerning the extent to which the school's capacity to realize its pedagogical goals is hindered by obstacles, by sectors (SD in brackets).

	ICT-related obstacles	Sectors		Effect size *r*
		Hebrew-speaking (*N* = 232)	Arabic-speaking (*N* = 65)	
B	Insufficient number of computers connected to the Internet	2.45 (1.32)	2.83 (1.26)	0.015*
E	Insufficient ICT equipment for instruction	2.89 (1.19)	3.27 (1.14)	0.018*
I	Teachers' lack of ICT skills	3.14 (.88)	2.86 (.96)	0.016*

*Significance level ≤ 0.05.

Table 11. Average ratings of Israeli principals' responses concerning the extent to which the school's capacity to realize its pedagogical goals is hindered by ICT-related obstacles, by sectors (SD in brackets).

ICT-related obstacles		Sectors		Effect size *r*
		Hebrew-speaking (*N* = 208)	Arabic-speaking (*N* = 70)	
B	Insufficient number of computers connected to the Internet	2.81 (1.23)	3.33 (1.02)	0.035*
C	Insufficient Internet bandwidth or speed	2.54 (1.25)	3.20 (1.14)	0.053*
D	Lack of special ICT equipment for disabled students	3.23 (1.47)	3.58 (0.91)	0.012*
E	Insufficient ICT equipment for instruction	2.97 (1.15)	3.56 (0.73)	0.056*
F	Computers are out of date	2.77 (1.16)	3.19 (0.79)	0.027*
G	Not enough digital educational resources for instruction	2.99 (1.13)	3.53 (0.74)	0.049*
H	Lack of ICT tools for science laboratory work	3.03 (1.16)	3.60 (0.82)	0.050*

*Significance level ≤ 0.01.

in fulfilling the school's pedagogical goals, displaying only seven of the nine items in which significant difference was found – those related to ICT.

The principals' perspective, as opposed to the ICT coordinators', expresses much higher inequity between the sectors in obstacles, hindering schools from achieving their pedagogical goals. Many items were rated by the principals as obstacles in the Arabic sector as significantly higher than the ratings in the Hebrew-speaking sector. Most items were connected to lack of infrastructure, hardware and software, and equipment being out of date. This picture is in clear correspondence with the data concerning differences in student–computer ratios between both sectors.

Discussion

This paper addresses issues concerning ICT-based pedagogical practices in Hebrew-speaking and Arabic-speaking schools in Israel. As presented in the background section, the framework within which the analysis was conducted has been composed upon the merging of two main dimensions concerning the implementation of ICT in the Israeli educational system: the first is related to the conflict between the commonly accepted perception of ICT as a lever for educational improvement and pedagogical innovation on one hand, and the subpopulation beliefs, values and cultural norms, on the other hand. The second dimension is related to the definition of ICT policies and the extent of their actual implementation over time in the two sub-systems considered – Arab- and Hebrew-speaking schools.

Concerning the first dimension, we frame our analyses in reference to the conflicts arising from the encounter between the perception of ICT as a trigger for change and the character of the Arab education system as largely a traditional one. These two forces, i.e. the need to seek for innovation as well as to preserve traditional structures and methods, generate interesting and dynamic processes within the schools; some of its characteristics were captured in the collected data.

As for educational policies and their implementation, two contrasting circumstances still coexist: the continuing social and economic disparities between the two ethnic populations, on the one hand, and the special efforts made by the Ministry of Education in the last decade to improve conditions in Arabic-speaking schools, on the other hand (Zuzovsky 2008). The inequalities between both educational systems were documented in published reports over the years, e.g. Lavi 1997, Sprinzak *et al.* 2003, and are also reflected in the Arab-speaking educators' (teachers, principals) perceptions of the qualities of their educational system. The recent years' attempts to bridge the gap is also well funded on policy decisions, e.g. as reported in the Dovrat committee report, 2005. These contrasting realities, i.e. the existence of disparities generated over the years and last years' educational policy decisions addressing them can be identified as well at the basis of processes taking place within the schools.

Based on the aforementioned, a preliminary depiction of the scenarios in both subsystems could be composed, serving as a basis for our hypotheses and analyses of the SITES 2006 data. Given that not all

policy decisions were satisfactorily implemented over the years and that even within the Arab-speaking sector, the situation among schools – concerning ICT infrastructure and ICT-based activities implementation – is clearly uneven, we hypothesized that significant difference will be found in all parameters measured, all in favour of the Hebrew-speaking sector. However, contrasting with these initial assumptions, the study's findings depicted a more complex picture.

Vision and goals

Concerning vision and goals, the principals in Arabic-speaking schools display higher positive attitudes than their colleagues in Hebrew-speaking schools towards the importance of ICT usage within their schools. Hence, there is a significant difference between the principals' perceptions in the two sub-populations regarding ICT implementation as a facilitator of change in pedagogy and as a means of promoting collaboration between teachers, both complying with novel educational paradigms. The Arab-speaking schools principals' position is of particular interest. In the context of the earlier discussed disparities in all different areas of the educational system, the principals' perception of ICT as high priority issue for their schools and important lever for reaching their educational objectives is highly interesting. It seems that efforts made to empower Arab-speaking schools beginning in the 1990s had caused school leaders to envisage their schools as change agents of the whole Arab sub-population (Sprinzak *et al.* 2003).

ICT implementation

Concerning actual implementation, according to findings regarding math and science teachers' reports on ICT-based practices, Arabic-speaking mathematics teachers indicate greater ICT usage in their target class (eighth grade). Among the several reasons for ICT implementation in primary and secondary education, Voogt emphasizes two rationales: the pedagogical rationale and the social rationale (Voogt 2008). The combination of these two rationales plays an important role within the Arab-speaking schools: math, being one of the basic curricular subjects, is nurtured as a means of upgrading schooling within the sector as well as a means of socially upgrading the Arab-speaking sector in Israel.

However, among science teachers, Hebrew-speaking teachers indicate greater ICT usage in their target class. This may be the result of science being associated with collaborative learning, complying with an emerging pedagogical paradigm that is found more within the Hebrew-speaking sector compared with the Arab-speaking sector (Nachmias *et al.* 2009). Also, the power of the Internet in modeling and visualizing scientific phenomena (Ernst & Clark 2009) is limited among Arab-speaking schools because of lower connectivity to the Internet in spite of the lack of differences between the means by which traditional science is taught in the two sub-sectors, e.g. science labs (Nachmias *et al.* 2009).

Perceived obstacles

Regarding perceived difficulties and obstacles for the implementation of ICT-based practices in both sub-populations, Arabic-speaking schools indicate lack of sufficient infrastructure as a major obstacle hindering these practices, while in the Hebrew sector, a main obstacle is the lack of ICT skills among teachers. This state of affairs is a result of two main factors. The first is the allocation of resources policy in the early stages of the Israeli computerization program for all schools (including Hebrew and Arab speakers) favouring the acquisition of infrastructure and equipment and to a far lesser degree, supporting implementation processes or the development of teachers' ICT skills (Mioduser *et al.* 2006). The second factor is the existence, still, of a significant gap in terms of resources allocation by the Israeli relevant ministries between the two sub-populations As a result, Hebrew-speaking schools in possession of better infrastructures focus their attention on the teachers' incomplete formation, while Arab-speaking schools (because of the resources allocation gap) emphasize more the infrastructure problems.

Implications

Prospective lines of action for endorsing innovative practices using technology in both sectors may include a number of actions in different areas. In terms of infrastructure, although there is some improvement altogether in the student–computer ratio in Israeli schools

and in connectivity to the Internet, Arab schools are still behind, and the student–computer ratio is almost twice as much as in Hebrew-speaking schools. Closing the gap between the sectors is one of the basic actions to be carried out as part of a general tendency to facilitate ICT implementation in schools in both sectors.

Policy within schools in both sectors encourages ICT implementation. In Arab-speaking schools, principals further see ICT as a lever for lifelong learning and as a means of achieving progress within the school and beyond the years of formal education. This indeed reflects aspirations of equity and equal opportunity within the Arab sector in Israel – and certainly should be encouraged by policymakers on an equal basis in both sectors.

As for obstacles hindering the school's capacity to realize its pedagogical goals – this should be treated differentially in the Hebrew-speaking sector and in the Arab-speaking sector, emphasizing each sector's specific needs, and in accordance with data derived from several items in the questionnaires, an emphasis on infrastructure enhancement in schools in the Arab sector and an emphasis on ICT skills in the Hebrew-speaking sector. Findings relating to the different emphases may explain why Hebrew-speaking mathematics teachers found ICT less effective than the Arab-speaking mathematics teachers in spite of the similar resources available to teachers in both Israeli sectors, e.g. spreadsheets, simulations, online resources, drill and practice software.

Notwithstanding, attempts should be made to close gaps between the two populations also by means of cooperation, collaboration, sharing of ideas and innovative models of ICT implementation as well as knowledge and experience between policymakers and practitioners from both sectors. Efforts should be made in all schools to upgrade all aspects of ICT implementation, especially in facilitating innovative practices and lifelong learning skills.

References

Albirini A. (2006) Cultural perceptions: the missing element in the implementation of ICT in developing countries. *International Journal of Education and Development Using Information and Communication Technology* **2**, 49–65.

Bissel T. (2004) The digital dilemma: preserving Native American culture while increasing access to information technology on reservations. *Journal of Law, Technology and Policy* **1**, 129–150.

Bourdieu P. (1993) *The Field of Cultural Production*. Columbia University Press, New York.

Central Bureau of Statistics (2008) *Annual Facts and Figures*. Central Bureau of Statistics, Jerusalem. [Hebrew].

Chen A., Mashhadi A., Ang D. & Harkrider N. (1999) Cultural issues in the design of technology-enhanced learning environments. *British Journal of Educational Technology* **30**, 217–230.

Dovrat Committee – Task Force for the Advancement of Education in Israel (2005) *National Plan for Education*. Government of Israel, Jerusalem. [Hebrew].

Ernst J.V. & Clark A.C. (2009) Technology-based content through virtual and physical modeling: a national research study. *Journal of Technology Education* **20**, 23–36.

Flum H. & Cinamon R. (2006) Socio-cultural differences between Jewish and Arab teacher's attitudes toward career education in Israel. *International Journal for Educational and Vocational Guidance* **6**, 123–140.

Khattab N. (2003) Explaining educational aspirations of minority students: the role of social capital and students' perceptions. *Social Psychology of Education* **6**, 283–302.

Knesset Research and Information Center (2008) *Background Report on School Outcomes in the Arab Sector Presented to the Child Rights Committee in the Knesset*. Knesset Research and Information Center, Jerusalem, Israel.

Kvasny L. (2006) Cultural (Re)production of digital inequality in a US community technology initiative. *Information, Communication & Society* **9**, 160–181.

Lavi V. (1997) *Differences in Resources and Achievement in the Arab Education in Israel*. Florsheimer Institute for Policy Studies, Jerusalem.

Law N., Pelgrum W.J. & Plomp T. (2008) *Pedagogy and ICT Use in Schools around the World*. CERC, Springer, HK.

Loch K., Straub D. & Kamel S. (2003) Diffusing the Internet in the Arab world: the role of social norms and technological culturation. *IEEE Transactions on Engineering Management* **50**, 45–63.

Maier-Rabler U. (2002) Cultural aspects and digital divide in Europe. *Medien Journal* **3**, 14–32. Available at: http://www.icts.sbg.ac.at/media/pdf/pdf82.pdf (last accessed 19 October 2010).

Ministry of Education (2007) *The Education System: Facts and Figures*. Ministry of Education, Jerusalem. [Hebrew].

Ministry of Education (2008) *The Education System: Facts and Figures*. Ministry of Education, Jerusalem, Israel. [Hebrew].

Mioduser D., Nachmias R., Tubin D. & Forkosh Baruch A. (2006) *Innovative Pedagogical Practices Using Information and Communication Technologies*. Ramot, Tel Aviv. [Hebrew].

Nachmias R., Mioduser D. & Forkosh-Baruch A. (2008) Innovative pedagogical practices using technology: the curriculum perspective. In *International Handbook of Information Technology in Education* (eds J. Knezek & J. Voogt), pp. 163–180. Springer, New York.

Nachmias R., Mioduser D. & Forkosh Baruch A. (2009) *SITES 2006 ICT in Mathematics and Science Education Study in Israel*. Ramot, Tel-Aviv. [Hebrew].

Pinkett R. (2000) *Bridging the digital divide: sociocultural constructionism and an asset-based approach to community technology and community building*. Paper presented at the 81st Annual Meeting of the American Educational Research Association (AERA) New Orleans, LA.

Rivlin-Zor G. & Zoabi I. (2005) *The Situation in Pre-School Education in the Arab-Sector in Israel: Characteristics, Facts and Conclusions*. The Abraham Fund Initiatives, Jerusalem, Israel. [Hebrew].

Shavit Y. (1990) Arab and Jewish minorities in Israeli Education. *American Sociological Review* **55**, 115–126.

Sprinzak D., Bar E., Levi-Mazloum D. & Piterman D. (2003) *Facts and Figures*. Ministry of Education, Economic and Budgeting Administration, Jerusalem, Israel. [Hebrew].

Trimikliniotis N. (2004) Mapping discriminatory landscapes in a divided educational system: the case of Cyprus. *Cyprus Review* **15**, 53–86.

Voogt J. (2008) IT and curriculum processes: dilemmas and challenges. In *International Handbook of Information Technology in Education* (eds J. Knezek & J. Voogt), pp. 117–132. Springer, New York.

Warschauer M. (2002) Reconceptualizing the digital divide. *First Monday* **7**, 7. Available at: http://www.firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/viewArticle/967/888 (last accessed 19 October 2010).

Warschauer M. (2003) Dissecting the 'digital divide': a case study in Egypt. *Information Society* **19**, 297–304.

Zuzovsky R. (2008) Capturing the dynamics that led to the narrowing achievement gap between Hebrew-speaking and Arabic-speaking schools in Israel: findings from TIMSS 1999 and 2003. *Educational Research and Evaluation* **14**, 47–71.