ICT-supported learning for inclusion of people with special needs: Review of seven educational technology journals, 1970–2011

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Abstract

Research and development of information and communication technology (ICT)-supported learning for people with disabilities has not received adequate attention. It is also difficult to access research findings and developments in this field. Under the ENABLE Network of ICT Supported Learning for Disabled People (2011–2014) project, an emerging European Union reference point portal for end-users will provide this information for a broad audience. In the design phase of the project idea, the authors of this paper conducted a review of papers indexed in Web of Science to provide a needs assessment and a design template for the project objectives. The results of the search clearly showed that ICT-supported learning for people with special educational needs is in the domain of the educational technology journals, with more papers published in the British Journal of Educational Technology than in any other journal. This paper presents the results of a content analysis of all papers published from 1970 to 2011 in seven educational technology journals indexed in Web of Science. More papers were published from 2006 to 2011 (44.7%) than during any other of five periods examined. Findings in terms of ICT intervention, disability groups, groups of study participants by relationship with ICT, and research design, together with trends in published studies in terms of mainstreaming and inclusion, are presented. The main objective of the study was to identify the level of inclusion through analysis of educational context (special schools [30.51%], mainstream schools [28.81%] and general support for life [40.68%]). Based on content analysis, ICT interventions were classified into the two categories of technical intervention in the pedagogical context (62.71% of all papers published) and technical intervention in the wider context (37.29% of all papers published), with nine paper types identified: papers on ICT access, papers on teaching and learning methods, papers on development and testing of ICT solutions, reviews, assessments, papers on inclusion, papers on behavioural and social development, papers on use of information technology and papers on interaction. Papers were also categorised according to types of disability and according to groups of study participants by relationship with ICT. Published papers
were divided into four categories by research design: descriptive (49.15%), developmental (26.27%), experimental (17.8%), and developmental and experimental (6.78%). During the period from 1970 to 2000, papers examined design of learning materials with regard to particular categories of disability and particular accessibility needs, while papers published after 2000 also discussed universal design.

Based on the review, the authors of this paper have identified a need for application of universal design principles in research and development of learning environments to provide equal accessibility and inclusive education.

Practitioner Notes

What is already known about this topic

• The main dilemmas of teaching and learning for people with special needs are the dilemma of identification, the dilemma of curriculum and the dilemma of location (Norwich, 2008). The use of ICT-assisted learning is becoming increasingly significant in addressing these three dilemmas (Ralph, 2006).

What this paper adds

• This paper presents the results of a content analysis of all papers published from 1970 to 2011 in seven educational technology journals indexed in Web of Science. The results of the search clearly showed that ICT-supported learning for people with special educational needs is in the domain of the educational technology journals, with more papers published in the British Journal of Educational Technology than in any other journal.
• This paper presents trends in ICT-supported teaching and learning for people with special needs, examining ICT interventions used, disability groups investigated, participant group size, research design and trends in mainstreaming and inclusion.
• This paper focuses on how ICT-assisted learning provides accessibility and facilitates inclusion and integration. The issue of the potential of ICT-supported learning for the inclusion process of people with special needs has not been explored sufficiently. This study has determined that papers on this issue began to appear in 2001 and has categorised, in total, 17 papers in this category published during the period from 1970 to 2011.

Implications for practice and/or policy

• By addressing questions about the role of ICT for inclusion and mainstreaming, this paper raises broader issues of inclusion and social integration in modern society and the educational process, allowing researchers from various fields insight into the field of ICT-supported learning for people with special needs.
• ICT-supported learning is becoming important in formal educational settings, in nonformal settings and in general support for life. ICT-supported learning should be investigated and designed on the basis of universal design, providing accessibility and facilitating inclusion for all. The main conclusion derived from the papers reviewed is that research supporting the design of inclusive learning environments needs to address students with special needs and students who do not have special needs equally.
**Introduction**

The main dilemmas of teaching and learning for people with special needs are the dilemma of identification, the dilemma of curriculum and the dilemma of location (Norwich, 2008). The use of information and communication technology (ICT)-assisted learning is becoming increasingly significant in addressing these three dilemmas (Ralph, 2006). ICT has a transformative and equalising potential for efforts to achieve integration and inclusion of students with “special educational needs” in mainstream classrooms and society (Florian, 2003). This paper focuses on how ICT-assisted learning provides accessibility and facilitates inclusion and integration. It presents a review of published scientific papers on this topic for the period from 1970 to 2011. Analyses were conducted with regard to ICT interventions used, disability groups, groups of participants by their relationship with ICT, school level and the research designs of published studies, including sample size. The paper also summarises the research trends in published studies focusing on mainstreaming and inclusive educational opportunities.

In the last 40 years ICT has become an important part of learning and developmental support for children with special needs. In the past, attention to ICT in learning was restricted to experts in special education and ICT specialists. In the last several decades ICT has become an important part in the design of inclusive learning environments in mainstream schools and classrooms, with teachers in mainstream classrooms involved in ICT-supported learning for children with special needs (Istenic Starcic, 2010). This paper presents trends in ICT-supported teaching and learning for people with special needs, examining ICT interventions used, disability groups investigated, participant group size, research design and trends regarding mainstreaming and inclusion.

Some countries define one or two types of special needs (disability groups), as for example do Denmark and Austria (European Agency for Development in Special Needs Education, 2010). Others, like Poland (European Agency for Development in Special Needs Education, 2010), classify special needs into more than 10 categories, while most countries recognise from 6 to 10 kinds of special needs (Opara, 2009), as does, for example, the Belgian Flemish-speaking community (European Agency for Development in Special Needs Education, 2010). The term “special educational needs” has been used for 30 years to define the needs of children with developmental difficulties that affect learning, behaviour, social and emotional development, communication, ability and independence (Lindsay, 2007).

Shortly after the start of the second half of the 20th century, the idea of integration emerged in opposition to the segregationist school system, which separates the regular and special education systems. A new paradigm of integrated education for children with special needs emerged, based on new philosophical foundations and ethical values. It facilitated integration of children with special needs into a regular classroom environment, facilitating their engagement based on appropriate conditions and relationships of mutual acceptance and respect (Opara, 2007, 2009). Integration supports a child’s development and learning in the company of peers, providing social engagement (Kolenc & Lebaricˇ, 2007). The integration of a few decades ago has further developed into inclusion, based on postmodern philosophy, ethics and values such as human rights, absence of discrimination, equal opportunities and justice, from which developed the ideal of the modern heterogeneous school where every child is different (Opara, 2009). “Inclusive education constitutes the inalienable right of children with special needs to appropriate and effective education in mainstream schools” (Kavkler, 2007, p 77). Research on the effects of inclusion and inclusive approaches in education on pupils is inconclusive. Lindsay (2007) investigates the tension within inclusive education between the children’s rights and the effectiveness of educational processes and outcomes. While it is important in terms of providing equality to put
students with special needs in mainstream classrooms, this is not enough. In order for them to be fully included rather than just being present, a change in culture is needed within the teaching profession in order to produce suitable teaching practice, and according to Lindsay, there also needs to be research-based evidence for what constitutes optimal teaching and learning practice and children’s outcomes.

There is little literature available about the diversity of contexts in which children are educated (Davis & Florian, 2004). Recent research findings indicate that pedagogical practice is still not ready for inclusion (Runswick-Cole, 2011). This study deals with the use of ICT and its potential for inclusion of people with special needs. ICT could present an important contribution to differentiated instruction, establishing a creative learning environment and supporting teachers in an inclusive classroom (Istenic Starcic, 2010; Istenic Starcic, Cotic & Zajc, 2013). While ICT has the potential to promote inclusion and support differentiated instruction, the technology itself could also present the main obstacle to inclusion.

“For many disabled people, computers offer the potential to increase independence and quality of life and to reduce the degree of handicap caused by their disability (Neilson, Pickering & Vella, 1989, p 57).” In addition, “the use of information technology is often the vital link that enables disabled students to participate fully in learning (Wisdom et al. 2007, p 222).” “Information technology may be the only means for communication and self-expression for people with special needs (Kurhila & Laine, 2000, p 163),” and it can provide “access to their environment and opportunities for personal development which are otherwise denied them (Hegarty, Bostock & Collins, 2000, p 199).” “Assistive technology offers socially impaired individuals an environment in which they can learn the meaning of emotions and understand more about the way they communicate with their peers (Bishop, 2003, p 554).”

Hegarty et al (2000) present a definition of ICT intervention for special needs that considers psychological aspects (ie, attitudes and self-confidence) and technical aspects. A 4-category classification based on the World Health Organization classification of impairment, disability and handicap is used; the categories are cognitive difficulties, emotional difficulties, physical disability and sensory disability. The definition highlights the dimensions of activity and participation. In this context, ICT support therefore provides opportunities to increase performance in activities and/or opportunities to increase participation (Douglas, 2001). Lewis and Neill (2001) identified the following main functions of ICT support: interaction communication, physical control and access to the normal curriculum, subject-linked learning, reward/motivation, information technology skills, assessment, record-keeping and teacher support.

In this paper, the authors have focused on ICT-supported learning. They conducted a content analysis and identified two categories—technical intervention in the pedagogical context and technical intervention in the wider context—covering nine types of paper: papers on ICT access, papers on teaching and learning methods, papers on development and testing of ICT solutions, reviews, assessments, papers on inclusion, papers on behavioural and social development, papers on use of information technology and papers on interaction.

How equity of accessibility can be addressed has been investigated. Witt and McDermott (2004) report on the UK, where the Disability Discrimination Act (2002) regulates this for all education providers, requiring their compliance with accessibility legislation. The World Wide Web Consortium (W3C) defines three priority levels of Web accessibility provided by the use of tools (evaluation tools, repair tools and filter and transformation tools). Developers should apply the principles of inclusive design, barrier-free design, universal design and design for all (Witt & McDermott, 2004). Universal accessibility in a web-based education system has been explored, examining standards, interoperability, design and delivery (Iorio, Feliziani, Mirri, Salomoni & Vitali, 2006; Nevile & Treviranus, 2010). Seale and Cooper (2010) define technical, design and
conceptual tools for accessibility. Technical tools consist of authoring applications, evaluation applications and repair applications. Design tools for accessibility consist of standards and guidelines. Conceptual tools are metaphors and models. Universal design applies to the architectural environment and requires technological devices to be accessible for all users, including users with disabilities. Universal instructional design has been applied in education to address accessibility issues in instruction. Innovative approaches to utilising universal design have been studied, among them computer-assisted instruction (Silver, Bourke & Strehorn, 1998).


This paper also focuses on groups of study participants by relationship with ICT, structure of published papers and how disability groups are presented in the papers. To identify the research design, a 3-category classification was used based on Jonassen’s (1996) classification of educational communication and technology, which was also applied by Shih, Feng and Tsai (2008). The classification distinguishes experimental research based on experimental and control groups (Ross & Morrison, 1996); descriptive research based on descriptions of events or participants’ input describing, explaining, evaluating or investigating the problem (Kunpfer & McLellan, 1996); and developmental research focused on design, development and evaluation of interventions or solutions (Richey & Nelson, 1996).

Method
The research methodology used was a systematic review consisting of a literature search in the bibliographic resource Web of Science (WOS), one of the most frequently used databases in addition to Google Scholar and Scopus (Koler Povh, Južnič, Turk & Turk, 2011). Papers with ICT-supported learning for people with special needs as a topic were included in the review. The results of the search clearly showed that ICT-supported learning for people with special educational needs is in the domain of the educational technology journals. The authors therefore limited the scope of the paper search to the seven major educational technology journals covering this topic. Searches were conducted in January 2011 and updated in December 2011. A manual search of papers published from 1970 to the end of 2011 was performed in the selected journals. Qualitative analysis of data extracted from all included studies and analyses was performed. Based on the study objectives, categories of data were identified that addressed five research questions. The coding of studies was conducted by reading the abstracts and full texts of the papers. Studies addressing several topics were assigned several codes. The coding was performed by two coders. Intercoder reliability was checked, and agreement was found to be 0.87. Alignment of codes and resolution of differences were achieved by discussion.

Research questions
The following research questions were asked:

1. What is the overall state of research in the field of ICT-assisted learning for people with disabilities and/or with special needs in terms of ICT intervention?
2. What research topics related to ICT-assisted learning for people with disabilities and/or special needs were published with regard to specific disability groups?

3. Which groups of study participants by relationship with ICT are represented in the published research papers and what interventions did the participants experience?

4. Which research designs were applied in the studies?

5. What are the trends in published studies in terms of inclusion and mainstreaming?

**Instruments and data collection**

Data collection was conducted in two steps. In the first step, data were collected via search procedures undertaken in the WOS database. The second step was a manual search performed in educational technology and ICT-assisted learning journals in which the most relevant studies were published. Journals selected were *Computers and Education* (CE), the *British Journal of Educational Technology* (BJET), the *Journal of Computer Assisted Learning* (JCAL), *Educational Technology Research and Development* (ETR&D), *Educational Technology and Society* (ETS), the *Australasian Journal of Educational Technology* (AJET) and the *Turkish Online Journal of Educational Technology* (TOJET).

All relevant papers are listed in the reference list. Space does not allow the inclusion of the names of all authors in the text every time a research question is discussed, so one research question has been chosen as an example. Table 2 presents the full results for the second research question: What research topics related to ICT-assisted learning for people with disabilities and/or special needs were published with regard to specific disability groups?

**Selection criteria**

The first criterion for inclusion was that the study should be concerned with ICT-supported learning, not assistive technology in general. The second criterion was that the study should report on an intervention involving ICT-supported learning for people with disabilities.

**Content analysis of the research topics**

Content analysis was conducted using categories related to ICT-assisted learning and disability groups. During the data analysis, the selected categories and subcategories were refined using the constant-comparative method (Lincoln & Guba, 1985).

The finalised framework of research topics, categories and subcategories consisted of seven main coding variables:

- journal title;
- year of publication, starting with the first editions of the selected journal published in databases, from 1970 onwards;
- research design, which was analysed based on
  - research approach (qualitative, quantitative, mixed),
  - research type (experimental, descriptive, developmental; Jonassen, 1996),
  - research method (survey, experiment, case study, action research, etc.),
  - whether there was a control group and whether the control group also received intervention,
  - description and number of study participants or sample (learners, teachers and other groups) who experienced interventions,
  - research questions and/or variables;
- disability by group;
- educational context (special school, integration/inclusion in mainstream school, general support for life);
- educational level (preprimary, primary, secondary, tertiary, lifelong learning);
- type of ICT intervention (technical, pedagogical, wider-context; Conole & Oliver, 2007).
Results
In this section, the data are presented in the order in which the research questions were given previously, starting with ICT-supported learning interventions, followed by ICT-supported learning by disability group, then groups of participants by relationship with ICT and school level, then research designs and sample sizes, and finally the findings regarding inclusion and mainstreaming, outlining educational context (special school, integration/mainstream in mainstream school or general support for life).

The number of identified papers was 118 (all 118 papers are listed in the references section); the percentage of papers published during each of five time periods is presented in Figure 1. After the starting period of 1970–1985, the review findings identified growth during the periods of 1986–1995, 1996–2000 and 2001–2005 and extensive growth during the period 2006–2011.

Among the selected journals, BJET has the highest number of relevant papers (44), followed by CE (34) and JCAL (14). BJET published the most papers (18) during the period 2001–2005, and CE published the most (20) during 2006–2011. The number of relevant papers by journal is presented in Figure 2.

Based on the content, papers were divided into two groups according to whether they focused on the pedagogical or the wider context (Table 1). They fell into nine types: papers on ICT access, papers on teaching and learning methods, papers on development and testing of ICT solutions, reviews, assessments, papers on inclusion, papers on behavioural and social development, papers on use of information technology and papers on interaction.

Table 2, which lists all 118 papers, presents research topics related to ICT-assisted learning for people with disabilities and/or special needs, organised by disability group. Disability terms are used as originally published in the papers. Throughout the world, groups of persons with disabilities are classified very differently. In addition there are variations in terms between the USA and the UK, for example, “learning difficulties” versus “learning disabilities” (Lindsay, 2007). The information about past research in Table 2 will inform the future research, design and development of inclusive...
learning environments providing access to quality learning experiences based on universal accessibility standards for users with various preferences and accessibility needs.

In order to identify particular groups of study participants by relationship with ICT, the study also analysed who was being studied in the identified papers. The following categories were identified (Table 3): learners, teachers, learners and teachers, users, experts, mixed. Under the category of “not defined” are papers that did not identify to which of these groups study participants belonged. Table 4 presents the participants according to level of education. Analysis of the research designs is presented in Table 5. Data on the size of the target groups of study participants or samples are presented in Table 6. Papers in which empirical study with a sample or group of participants was not conducted are also listed. An analysis of educational context is presented in Table 7.

Research in mainstream schools has flourished in the most recent investigative period (2006–2011). Research in the field of inclusion has been less frequent: in total, 17 papers in this category were identified. Table 8 presents all papers about inclusion. Early papers about inclusion are concerned about access to technological equipment and Web access at institutional level as a means of promoting inclusion. Schools and educational authorities facilitated the use of information.

Figure 2: Number of papers about ICT-supported learning for people with special needs published in selected journals by publication year

Table 1: Number of papers published by publication year according to type of ICT-assisted learning intervention

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</thead>
<tbody>
<tr>
<td>Pedagogical context</td>
<td>2 (2.70)</td>
<td>16 (21.62)</td>
<td>8 (10.81)</td>
<td>16 (21.62)</td>
<td>32 (43.24)</td>
<td>74 (100)</td>
<td>62.71</td>
</tr>
<tr>
<td>Wider context</td>
<td>4 (9.09)</td>
<td>7 (15.91)</td>
<td>4 (9.09)</td>
<td>9 (20.45)</td>
<td>20 (45.45)</td>
<td>44 (100)</td>
<td>37.29</td>
</tr>
<tr>
<td>Total</td>
<td>6 (5.08)</td>
<td>23 (19.49)</td>
<td>12 (10.17)</td>
<td>25 (21.19)</td>
<td>52 (44.07)</td>
<td>118 (100)</td>
<td>100</td>
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</tbody>
</table>

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<table>
<thead>
<tr>
<th>Disability</th>
<th>Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speech defects/severe language disorder, cerebral palsy with writing difficulties, Down syndrome, Bliss/Makaton users, muscular dystrophy, special learning difficulties, communication problems, fragile X, visual impairment, poor motor control, severe spelling problems, writing difficulties, speech impairment</td>
<td></td>
</tr>
<tr>
<td>Moderate learning difficulties: slow learning, reading/writing problems, language difficulties, emotional and behavioural problems, poor memory retention, lack of concentration and immaturity</td>
<td></td>
</tr>
<tr>
<td>Communication disabilities (toddlers with Down syndrome); severe language, learning and behavioural disabilities (severe retardation, multiple handicaps, severe emotional disorders, autism, cerebral palsy)</td>
<td></td>
</tr>
</tbody>
</table>
Disabled (with both cognitive disability motor disability); children with deficiencies in mental programming
Adults/workers with severe development disabilities
Dyslexia

Attention deficit hyperactivity disorder (ADHD)

Asperger’s syndrome

Intellectual disability, acquired brain injury and dementia
Visual impairment; partial sight, learning difficulties, cerebral palsy, blindness, severe learning difficulties
Normal-stream pupils who are academically less able and who require extra guidance and assistance
Learning disabilities/difficulties

(High) risk for learning disabilities

Special learning needs

Mild to moderate learning disability
Severe learning disability

Children with mild learning difficulties in reading, mathematics or other school-related areas, with no additional sensory or physical impairments

<table>
<thead>
<tr>
<th>Disability</th>
<th>Papers</th>
</tr>
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<tbody>
<tr>
<td>spectrum conditions</td>
<td>and Ye (2010); Cheng et al (2010); Sahin and Cimen (2011); Doyle and Arnedillo-Sánchez</td>
</tr>
<tr>
<td>Cerebral palsy and mental retardation</td>
<td>(2011); Mintz, Branch, March and Lerman (2012)</td>
</tr>
<tr>
<td>Mobility impairment/wheelchair user, ADD/ADHD,</td>
<td></td>
</tr>
<tr>
<td>psychological/psychiatric disability, health/medically related</td>
<td></td>
</tr>
<tr>
<td>impairment, deafness/hardness of hearing, difficulty using hands</td>
<td></td>
</tr>
<tr>
<td>and/or arms, visual impairment (low vision), neurological impairment,</td>
<td></td>
</tr>
<tr>
<td>speech or communication impairment, total blindness, other</td>
<td></td>
</tr>
<tr>
<td>Motor disability</td>
<td>2001–2005: Valenti, Fioretti, Maurizi, Panti and Leo (2002); Germann, Broida and Broida</td>
</tr>
<tr>
<td>Socio-emotional difficulties</td>
<td>(2003)</td>
</tr>
<tr>
<td></td>
<td><strong>118 papers</strong></td>
</tr>
</tbody>
</table>
Table 3: Number of papers published by publication year according to group of study participants by relationship with ICT

<table>
<thead>
<tr>
<th>Category</th>
<th>1970–1985 (n, %)</th>
<th>1986–1995 (n, %)</th>
<th>1996–2000 (n, %)</th>
<th>2001–2005 (n, %)</th>
<th>2006–2011 (n, %)</th>
<th>Total (n, %)</th>
<th>Percentage of all papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learners</td>
<td>2 (3.57)</td>
<td>12 (21.43)</td>
<td>4 (7.14)</td>
<td>8 (14.29)</td>
<td>30 (53.57)</td>
<td>56 (100)</td>
<td>47.46</td>
</tr>
<tr>
<td>Teachers</td>
<td>1 (6.67)</td>
<td>2 (13.33)</td>
<td>1 (6.67)</td>
<td>4 (26.67)</td>
<td>7 (46.67)</td>
<td>15 (100)</td>
<td>12.71</td>
</tr>
<tr>
<td>Teachers and learners</td>
<td>0 (0.00)</td>
<td>5 (100.00)</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>5 (100)</td>
<td>4.24</td>
</tr>
<tr>
<td>Users</td>
<td>3 (20.00)</td>
<td>1 (6.67)</td>
<td>1 (6.67)</td>
<td>6 (40.00)</td>
<td>4 (26.67)</td>
<td>15 (100)</td>
<td>12.71</td>
</tr>
<tr>
<td>Experts</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>3 (100.00)</td>
<td>3 (100)</td>
<td>6 (100)</td>
<td>2.54</td>
</tr>
<tr>
<td>Mixed*</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>2 (22.22)</td>
<td>3 (33.33)</td>
<td>4 (44.44)</td>
<td>9 (100)</td>
<td>7.63</td>
</tr>
<tr>
<td>Not defined</td>
<td>0 (0.00)</td>
<td>3 (20.00)</td>
<td>4 (26.67)</td>
<td>4 (26.67)</td>
<td>4 (26.67)</td>
<td>15 (100)</td>
<td>12.71</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>6 (5.08)</td>
<td>23 (19.49)</td>
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<td>25 (21.19)</td>
<td>52 (44.07)</td>
<td>118 (100)</td>
<td>100</td>
</tr>
</tbody>
</table>

*Physical, communicational, emotional, intellectual, learning and cognitive, vision, orthopaedic/mobility, hearing disabilities, disorders or handicaps; Down syndrome, autism, cerebral palsy and others.

Table 4: Number of papers published by publication year according to school level

<table>
<thead>
<tr>
<th>Category</th>
<th>1970–1985 (n, %)</th>
<th>1986–1995 (n, %)</th>
<th>1996–2000 (n, %)</th>
<th>2001–2005 (n, %)</th>
<th>2006–2011 (n, %)</th>
<th>Total (n, %)</th>
<th>Percentage of all papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preprimary</td>
<td>0 (0.00)</td>
<td>1 (14.28)</td>
<td>2 (28.57)</td>
<td>0 (0.00)</td>
<td>5 (71.43)</td>
<td>7 (100)</td>
<td>5.93</td>
</tr>
<tr>
<td>Primary</td>
<td>0 (0.00)</td>
<td>3 (30.00)</td>
<td>0 (0.00)</td>
<td>3 (30.00)</td>
<td>4 (40.00)</td>
<td>10 (100)</td>
<td>8.47</td>
</tr>
<tr>
<td>Secondary</td>
<td>0 (0.00)</td>
<td>4 (40.00)</td>
<td>0 (0.00)</td>
<td>1 (10.00)</td>
<td>5 (50.00)</td>
<td>10 (100)</td>
<td>8.47</td>
</tr>
<tr>
<td>Primary and secondary</td>
<td>1 (25.00)</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>1 (25.00)</td>
<td>2 (50.00)</td>
<td>4 (100)</td>
<td>3.39</td>
</tr>
<tr>
<td>Primary, secondary and adult</td>
<td>1 (50.00)</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>1 (50.00)</td>
<td>2 (100)</td>
<td>2 (100)</td>
<td>1.69</td>
</tr>
<tr>
<td>Primary, secondary and college</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>1 (100.00)</td>
<td>0 (0.00)</td>
<td>1 (100)</td>
<td>0.85</td>
</tr>
<tr>
<td>Tertiary</td>
<td>1 (8.33)</td>
<td>1 (8.33)</td>
<td>0 (0.00)</td>
<td>3 (25.00)</td>
<td>7 (58.30)</td>
<td>12 (100)</td>
<td>10.17</td>
</tr>
<tr>
<td>Lifelong learning</td>
<td>0 (0.00)</td>
<td>2 (20.00)</td>
<td>1 (10.00)</td>
<td>5 (50.00)</td>
<td>2 (20.00)</td>
<td>10 (100)</td>
<td>8.47</td>
</tr>
<tr>
<td>Not defined</td>
<td>3 (4.84)</td>
<td>12 (19.35)</td>
<td>9 (14.52)</td>
<td>11 (17.74)</td>
<td>27 (43.55)</td>
<td>62 (100)</td>
<td>52.54</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>6 (5.08)</td>
<td>23 (19.49)</td>
<td>12 (10.17)</td>
<td>25 (21.19)</td>
<td>52 (44.07)</td>
<td>118 (100)</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 5: Number of papers published by publication year according to research design

<table>
<thead>
<tr>
<th>Category</th>
<th>1970–1985 (n, %)</th>
<th>1986–1995 (n, %)</th>
<th>1996–2000 (n, %)</th>
<th>2001–2005 (n, %)</th>
<th>2006–2011 (n, %)</th>
<th>Total (n, %)</th>
<th>Percentage of all papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Descriptive</td>
<td>2 (3.45)</td>
<td>14 (24.14)</td>
<td>4 (6.90)</td>
<td>10 (17.24)</td>
<td>28 (48.28)</td>
<td>58 (100)</td>
<td>49.15</td>
</tr>
<tr>
<td>Developmental</td>
<td>4 (12.90)</td>
<td>5 (16.13)</td>
<td>3 (9.68)</td>
<td>9 (29.03)</td>
<td>10 (32.26)</td>
<td>31 (100)</td>
<td>26.27</td>
</tr>
<tr>
<td>Experimental</td>
<td>0 (0.00)</td>
<td>4 (19.05)</td>
<td>4 (19.05)</td>
<td>3 (14.29)</td>
<td>10 (47.62)</td>
<td>21 (100)</td>
<td>17.80</td>
</tr>
<tr>
<td>Developmental and experimental</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>1 (12.50)</td>
<td>3 (37.50)</td>
<td>4 (50.00)</td>
<td>8 (100)</td>
<td>6.78</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>6 (5.08)</td>
<td>23 (19.49)</td>
<td>12 (10.17)</td>
<td>25 (21.19)</td>
<td>52 (44.07)</td>
<td>118 (100)</td>
<td>100</td>
</tr>
</tbody>
</table>

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technology for classroom preparation and teaching for teachers working with students with special needs. Portable computers were distributed to schools across the UK in 1999 (Lewis & Neill, 2001). Web pages connected special schools and pupil referral units to society and facilitated the dissemination of information on the processes related to the issues of separation and inclusion. Abbott and Cribb (2001) reported on recommendations for website accessibility. Based on the Special Educational Needs and Disability Act, standards and repair tools for website accessibility were the focus of a study of academic websites in the UK in 2004 (Witt & McDermott, 2004). ICT was investigated in terms of providing pedagogical and technological inclusion for people with physical and/or learning disabilities. A study of inclusion in electronic classrooms included six courseware environments for people who were blind or visually impaired, were mobility-impaired, or had a learning disability. The main findings indicated the need for experience with network environments, immediately available assistance and adaptive technology. Needs of users with various disabilities were studied to identify requirements and solutions for assisting them in electronic classrooms (Luke, 2002). Initiatives seeking universal accessibility in web-based education systems concerned standards for and development and delivery of computer-based material to individual users with various preferences and particular accessibility needs (Iorio et al, 2006; Nevile & Treviranus, 2010).

Table 6: Number of papers published by publication year according to sample size

<table>
<thead>
<tr>
<th>Category</th>
<th>1970–1985 (n, %)</th>
<th>1986–1995 (n, %)</th>
<th>1996–2000 (n, %)</th>
<th>2001–2005 (n, %)</th>
<th>2006–2011 (n, %)</th>
<th>Total (n, %)</th>
<th>Percentage of all papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–10</td>
<td>0 (0.00)</td>
<td>2 (7.41)</td>
<td>3 (11.11)</td>
<td>9 (33.33)</td>
<td>13 (48.15)</td>
<td>27 (100)</td>
<td>22.88</td>
</tr>
<tr>
<td>10–50</td>
<td>0 (0.00)</td>
<td>2 (7.69)</td>
<td>2 (7.69)</td>
<td>5 (19.23)</td>
<td>17 (65.38)</td>
<td>26 (100)</td>
<td>22.03</td>
</tr>
<tr>
<td>50–100</td>
<td>0 (0.00)</td>
<td>3 (37.50)</td>
<td>1 (12.50)</td>
<td>2 (25.00)</td>
<td>2 (25.00)</td>
<td>8 (100)</td>
<td>6.78</td>
</tr>
<tr>
<td>100–200</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>1 (25.00)</td>
<td>3 (75.00)</td>
<td>4 (100)</td>
<td>3.39</td>
</tr>
<tr>
<td>200–500</td>
<td>0 (0.00)</td>
<td>1 (12.50)</td>
<td>0 (0.00)</td>
<td>1 (12.50)</td>
<td>6 (75.00)</td>
<td>8 (100)</td>
<td>6.78</td>
</tr>
<tr>
<td>500–1000</td>
<td>1 (100.00)</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>1 (100)</td>
<td>0.85</td>
</tr>
<tr>
<td>Over 1000</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td>2 (66.67)</td>
<td>1 (33.33)</td>
<td>3 (100)</td>
<td>2.54</td>
</tr>
<tr>
<td>No sample</td>
<td>5 (12.2)</td>
<td>15 (36.59)</td>
<td>6 (14.63)</td>
<td>5 (12.20)</td>
<td>10 (24.39)</td>
<td>41 (100)</td>
<td>34.75</td>
</tr>
<tr>
<td>Total</td>
<td>6 (5.08)</td>
<td>23 (19.49)</td>
<td>12 (10.17)</td>
<td>25 (21.19)</td>
<td>52 (44.07)</td>
<td>118 (100)</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 7: Number of papers published by publication year according to educational context

<table>
<thead>
<tr>
<th>Category</th>
<th>1970–1985 (n, %)</th>
<th>1986–1995 (n, %)</th>
<th>1996–2000 (n, %)</th>
<th>2001–2005 (n, %)</th>
<th>2006–2011 (n, %)</th>
<th>Total (n, %)</th>
<th>Percentage of all papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special school</td>
<td>1 (2.78)</td>
<td>9 (25.00)</td>
<td>3 (8.33)</td>
<td>11 (30.56)</td>
<td>12 (33.33)</td>
<td>36 (100)</td>
<td>30.51</td>
</tr>
<tr>
<td>Mainstream</td>
<td>1 (2.94)</td>
<td>7 (20.59)</td>
<td>0 (0.00)</td>
<td>4 (11.76)</td>
<td>22 (64.71)</td>
<td>34 (100)</td>
<td>28.81</td>
</tr>
<tr>
<td>General support in life</td>
<td>4 (8.33)</td>
<td>7 (14.58)</td>
<td>9 (18.75)</td>
<td>10 (20.83)</td>
<td>18 (37.50)</td>
<td>48 (100)</td>
<td>40.68</td>
</tr>
<tr>
<td>Total</td>
<td>6 (5.08)</td>
<td>23 (19.49)</td>
<td>12 (10.17)</td>
<td>25 (21.19)</td>
<td>52 (44.07)</td>
<td>118 (100)</td>
<td>100</td>
</tr>
</tbody>
</table>

ICT supports people with impairment in social communication and social participation, providing them with a safe environment (Bishop, 2003). Collaborative work environments are needed in inclusion processes, facilitating collaboration and interaction in inclusive learning environments. Computer-supported collaborative learning is suitable for addressing individual needs, especially needs related to disability, with regard to social groups and providing interaction with peers (Lewis et al, 2005; Mavrou et al, 2010; Tan & Cheung, 2008). Based on the idea of design for all, a developmental study with an interactive whiteboard was undertaken by Freire et al.

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<table>
<thead>
<tr>
<th>Authors, year of publication and journal</th>
<th>Research design</th>
<th>Number and description of participants</th>
<th>Disability group</th>
<th>Educational level and context</th>
<th>Type of ICT intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbott &amp; Cribb, 2001; BJET</td>
<td>Descriptive Questionnaire survey</td>
<td>1132 information technology coordinators and head teachers</td>
<td>Special educational needs</td>
<td>Primary and secondary schools, pupil referral units and special schools</td>
<td>WWW homepage in special schools and pupil referral units to support inclusion</td>
</tr>
<tr>
<td>Luke, 2002; ET&amp;S</td>
<td>Descriptive Qualitative Questionnaire Observation</td>
<td>8 persons</td>
<td>Physical and/or learning disability; blind, vision-impaired, mobility-impaired and learning-disabled</td>
<td>Inclusion in an electronic classroom—examination of accessibility in six courseware environments</td>
<td></td>
</tr>
<tr>
<td>Bishop, 2003; JCAL</td>
<td>Descriptive Observation</td>
<td>13 adults</td>
<td>Social impairment; autistic spectrum disorders, general social phobia</td>
<td>Lifelong learning</td>
<td>Mobile Internet technology in communication apprehension</td>
</tr>
<tr>
<td>Wearmouth, Smith &amp; Soler, 2004; BJET</td>
<td>Descriptive Mixed Case study</td>
<td>3 tutors and 16 students</td>
<td>Special educational needs</td>
<td>Postgraduate education for teachers promoting inclusion</td>
<td>Computer conferencing for communities of practice</td>
</tr>
<tr>
<td>Witt &amp; McDermott, 2004; BJET</td>
<td>Descriptive Overview of 2200 websites</td>
<td>Academic institutions</td>
<td>Physical and/or learning disability</td>
<td>Higher education</td>
<td>Website accessibility; standards and tools</td>
</tr>
<tr>
<td>Winter &amp; McGhie-Richmond, 2005; JCAL</td>
<td>Descriptive Collaborative case study</td>
<td>40 students in special education graduate course</td>
<td>Special educational needs</td>
<td>Higher education, teacher education</td>
<td>Computer conferencing</td>
</tr>
<tr>
<td>Lewis &amp; Neill, 2001; BJET</td>
<td>Descriptive Quantitative Questionnaire survey</td>
<td>1279 special education needs coordinators</td>
<td>Special educational needs</td>
<td>Primary schools</td>
<td>Portable computers for special needs education coordinators</td>
</tr>
<tr>
<td>Lewis, Trushell &amp; Woods, 2005; BJET</td>
<td>Descriptive Interview Questionnaire Sociometric testing</td>
<td>3 children</td>
<td>Asperger’s syndrome</td>
<td>Primary school</td>
<td>ICT-supported groupwork interaction to support inclusion of students with Asperger’s syndrome</td>
</tr>
<tr>
<td>Bain &amp; Parkes, 2006; BJET</td>
<td>Developmental Observation</td>
<td>30 teachers</td>
<td>Students with learning disabilities</td>
<td>Secondary school</td>
<td>Curriculum-authoring tools for inclusive classroom teaching practice in a secondary school</td>
</tr>
<tr>
<td>Authors, year of publication and journal</td>
<td>Research design</td>
<td>Number and description of participants</td>
<td>Disability group</td>
<td>Educational level and context</td>
<td>Type of ICT intervention</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>----------------</td>
<td>----------------------------------------</td>
<td>-----------------</td>
<td>-------------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Nevile &amp; Treviranus, 2010; JETS</td>
<td>Descriptive</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>Universal accessibility and interoperability of web-based educational systems—AccessForAll</td>
</tr>
<tr>
<td>Iorio et al, 2006; JETS</td>
<td>Descriptive</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>Accessible learning objects</td>
</tr>
<tr>
<td>Mavrou, Lewis &amp; Douglas, 2010; BJET</td>
<td>Descriptive</td>
<td>40 pupils</td>
<td>Special educational needs</td>
<td>Primary school</td>
<td>Computer-based collaborative learning—interaction in inclusive classroom</td>
</tr>
<tr>
<td>Tan &amp; Cheung, 2008; CE</td>
<td>Descriptive</td>
<td>1 pupil</td>
<td>Pupil with attention deficit hyperactivity disorder</td>
<td>Preprimary school</td>
<td>Computer-supported collaborative learning in inclusive classroom</td>
</tr>
<tr>
<td>Istenic Starcic, 2010; TOJET</td>
<td>Descriptive</td>
<td>45 students</td>
<td>Special educational needs</td>
<td>Higher education, teacher education</td>
<td>Learning management system/courseware</td>
</tr>
<tr>
<td>Istenic Starcic &amp; Niskala, 2010; BJET</td>
<td>Descriptive</td>
<td>23 teachers</td>
<td>Special educational needs</td>
<td>Vocational special schools and mainstream vocational school</td>
<td>Learning management system/courseware</td>
</tr>
<tr>
<td>Freire et al, 2010; CE</td>
<td>Developmental Case study</td>
<td>1 blind participant</td>
<td>Blindness</td>
<td>Secondary school</td>
<td>Interactive whiteboard supporting collaborative learning; blind students’ use of graphical content with interactive whiteboards,</td>
</tr>
<tr>
<td>Parsons, Daniels, Porter &amp; Robertson, 2006; BJET</td>
<td>Descriptive</td>
<td>9 day-care services and 14 homes</td>
<td>Adults with learning disabilities</td>
<td>Adult education</td>
<td>ICT use in day-care centres for adults with learning disability to promote their community participation</td>
</tr>
</tbody>
</table>

n/a, not applicable.
(2010) to facilitate inclusion of blind students in collaborative learning. Parsons, Daniels, Porter and Robertson (2006a) investigated the use of ICT to promote community participation in a day-care centre for adults with learning difficulties.

The professional development of teachers to prepare them for inclusion relies on the use of ICT-supported learning, that is, on providing them with skills and competences for the use of ICT for their own professional learning and for teaching. Computer conferencing facilitates communities of practice in which teachers exchange their experiences and share their knowledge (Wearmouth et al., 2004), providing exchange between the experienced and novices (Winter & McGhie-Richmond, 2005). Istenic Starcic (2010) reports on the development of competences in initial teacher education for designing learning environments addressing individual needs to facilitate differentiated instruction in inclusive classrooms.

Bain and Parkes (2006) investigated a curriculum-authoring tool for inclusive classrooms in secondary education, based on teaching approaches in inclusive classrooms: direct or explicit teaching, cooperative learning, team accelerated instruction methodology and peer tutoring. Istenic Starcic and Niskala (2010) conducted a study of learning management systems used in daily teaching and planning with teachers of special vocational education and teachers in a mainstream vocational school. It has benefits for teachers of students with special needs in planning and conducting lessons, learning material design and monitoring students’ progress.

Discussion
Since 1970, the number of papers on ICT-supported learning published in selected Social Sciences Citation Index journals has increased, as shown in Figure 1. Findings presented in the results section are discussed here according to research topic.

ICT intervention
Based on their content, papers fall into two broad categories: those in which the dominant theme is technology in pedagogical practice and those dealing with technology reaching outside pedagogical practice into a wider context. Within these categories nine dominant, recurring paper types emerged, listed below. Some types appear only in one of the two categories, while others can be found in both.

Pedagogical context
- Papers on ICT access (for example: Ari & Inan, 2010)
- Papers on teaching and learning methods (for example: Johnson & Hegarty, 2003; Kleemans, Segers, Droop & Wentink, 2010; McEvoy & McConkey, 1991; Reis et al., 2010; Schloss, 1986)
- Papers on development and testing of ICT solutions (for example: Chambers, 1997; Newell, Booth & Beattie, 1991; Singleton & Simmons, 2001)
- Reviews (for example: Douglas, 2001; Hartley, 2007)
- Assessments (for example: Mioduser, Tur-Kaspa & Leitner, 2000; Nicol & Anderson, 2000)
- Papers on inclusion (Abbott & Cribb, 2001; Bain & Parkes, 2006; Bishop, 2003; Freire et al., 2010; Iorio et al., 2006; Istenic Starcic, 2010; Istenic Starcic & Niskala, 2010; Lewis & Neill, 2001; Lewis et al., 2005; Luke, 2002; Mavrou et al., 2010; Nevile & Treviranus, 2010; Parsons et al., 2006a; Tan & Cheung, 2008; Wearmouth et al., 2004; Winter & McGhie-Richmond, 2005; Witt & Mc Dermott, 2004)
- Papers on interaction (for example: Cheng, Chiang, Ye & Cheng, 2010)

Wider context
- Papers on ICT access (for example: Aspinall & Hegarty, 2001)
- Papers on development and testing of ICT solutions (for example: Brown, 1987; Ohene-Djan, Zimmer, Gorle & Naqvi, 2003; Walker & Rostron, 1999)
Reviews (for example: Neilson et al., 1989)
Assessments (for example: Houghton et al., 2004; Wilding, 1999; Sánchez & Sáenz, 2010)
Papers on behavioural and social development (for example: Doyle & Arnedillo-Sánchez, 2011; Jones, 1996; Ozdemir, 2008; Seale, 2001)
Papers on use of information technology (for example: Eden & Heiman, 2011)

Disability groups
A detailed overview of types of special needs referred to by authors by year is presented in Table 2 and includes all 118 papers reviewed. The table records the terms used by authors. In the last 40 years, papers have covered many different categories of identified special needs and/or disability (the most common/significant being attention deficit hyperactivity disorder, dyslexia, Down syndrome, physical and mental handicaps, hearing impairment/deafness, visual impairment/blindness, severe developmental disabilities, Asperger’s syndrome, autism, language and reading difficulties/language impairment, cerebral palsy, motor disability, socio-emotional difficulties, combined intellectual and sensory impairments, learning difficulties/disabilities, communication disabilities and intellectual disabilities). In addition to papers that looked at specific types of special needs, there were 17 papers that explored special needs in general rather than addressing particular needs (for example Abbott & Cribb, 2001; Adler, 1994; Cifuentes, Sharp, Bulu, Benz & Stough, 2010; Gabrielli, Mirabella, Kimani & Catarci, 2006; Hartley, 2007; Lewis & Neill, 2001; MacKenzie, Jones & Payne, 1970; Witt & McDermott, 2004). The first reviewed paper published on ICT-assisted learning (MacKenzie et al., 1970) investigated the use of ICT in mainstream and special schools.

Most often, the authors write about learning difficulties or disabilities, with some authors writing about (high) risk for learning disabilities (Mioduser et al., 2000; Shamir & Shlafer, 2011) and others discussing mild and moderate learning disabilities (Brown, 1987; Johnson & Hegarty, 2003). Aspinall and Hegarty (2001), Sheehy (2005) and Istenic Starcic and Niskala (2010), for example, write about severe learning disabilities, while those writing about special learning needs include Sepehr and Harris (1995), Winter and McGhie-Richmond (2005) and Istenic Starcic (2010). Most often, learning disabilities in general are mentioned. Examples include Nicol and Anderson (2000); Beale (2005); Bottge, Rueda, Kwon, Grant and LaRoque (2009); and Seo and Woo (2010).

The second most commonly mentioned type of special need in the reviewed papers is hearing impairment and deafness. The first paper about ICT-assisted learning for the hearing-impaired was written in 1984 by Snell, Dickson and Ingram. Many followed; for example Hertzog, Stinson and Keiffer (1989); Bloor et al. (1992); Liu and Hong (2007); and Yang, Lay, Liou, Tsao and Lin (2007). The first paper about ICT-assisted learning for the deaf was also published in the 1980s. It was written by Ward, Lindley, Rostron, Sewell and Cubie (1985). Other papers followed, for example Walker and Rostron (1999); Ohene-Djan et al. (2003); and Ditcharoen, Naruedomkul and Cercone (2010).

The third most frequently dealt with type of special needs is autism, referred to in studies on “autism” (see, for example, Chen, Wu, Lin, Tasi & Chen, 2009), “autism and mental retardation” (for example Sahin & Cimen, 2011), “autistic spectrum disorders” (for example Parsons et al., 2006b) and “autism spectrum conditions” (Cheng & Ye, 2010).

Groups of study participants
Based on participants’ relationship to ICT, papers were categorised as concerning learners, teachers, teachers and learners, users or experts. Most of these contributions were engaged with learners, with a substantial proportion of papers discussing ICT use for learners with learning difficulties or disability. In 1987, Wright and Anderson published the findings of an experiment that proved that children with learning difficulties perform better with the help of computers than
with traditional methods. Seo and Woo (2010) determined that computer-assisted learning is beneficial for intended learning outcomes in mathematics by examining study supported by the instructional program Math Explorer. Studies indicate the use of computer-supported communication by email and other means (e.g., SMS) provides social and emotional support (Eden & Heiman, 2011).

Some early papers investigate difficulties of learners in accessing ICT-supported learning and examine assistive technology devices and the design of learning materials with regard to particular categories of disability (MacCann, 1996), while more recent papers focus on universal design (Iorio et al., 2006; Nevile & Treviranus, 2010).

Early papers focus on establishment of websites for special education to connect the special education environment to the community (Abbott & Cribb, 2001) and on providing computers (Lewis & Neill, 2001). Accessibility of websites and other e-learning resources remains a problem and was studied in colleges and universities in 2009 (Fichten et al., 2009). Attitude towards and acceptance of technology is an important factor in ICT use. Computer anxiety has been compared between adolescents with language impairment and adolescents without impairment. Complex relationships between different psychological and emotional factors impact the use of ICT. Adolescents at greater risk may require more support in ICT use (Conti-Ramsden, Durkin & Walker, 2010).

Some papers explore assistive devices and characteristics of ICT-assisted learning for people with particular categories of disabilities (Table 2). Learning-management systems and virtual environments have been proven to facilitate social interaction and connectedness (Lewis et al., 2005; Mavrou et al., 2010; Tan & Cheung, 2008) and provide safe environments (Bishop, 2003).

Papers also investigate the benefits of ICT-supported learning for people with special needs. These are in providing social and emotional support, increasing participation, connecting them to social contexts which would otherwise not be accessible, and facilitating inclusion and access to a mainstream curriculum (Table 8). From the assistive, compensatory and enabling function of ICT, the focus has moved towards equal engagement of students with disabilities and towards the quality of teaching and learning methods with regard to providing differentiated instruction, developing competence in ICT use and providing opportunities for creative expression.

Papers that examine teachers’ use of ICT for students with special needs focus on ICT in teachers’ initial education and professional development and learning. The main objective is to facilitate teachers’ competence with ICT in their professional learning and teaching. Hegarty et al. (2000) discuss the need for awareness to rise about psychological factors of attitude and self-confidence that determine how ICT is used. The benefits of computer conferencing and communities of practice in the initial education of special-education teachers have been highlighted (Wearmouth et al., 2004; Winter & McGhie-Richmond, 2005). Winter and McGhie-Richmond (2005) investigated what effect computer conferencing would have on collaboration between novice and expert teachers of special-needs students. In line with efforts to facilitate the use of ICT in teaching to promote inclusion, some papers investigate initial education of teachers to prepare them for classroom management of differentiated instruction according to learners’ diverse needs, including needs related to disability. Curriculum-authoring tools (Bain & Parkes, 2006) and learning-management systems (Istenic Starcic, 2010) have been investigated.

Papers that engaged with both learners and teachers present testing, implementing or evaluating of ICT solutions in pedagogical practice and evaluation of ICT use for children with special needs. Papers investigating solutions aim to study the impacts and benefits for learners and teachers in language learning and in mathematics. Singleton and Simmons (2001) identify Wordshark—a multisensory drill-and-practice program for improving spelling and word recognition, widely used in primary and secondary education of special-needs students—as facilitating their...
motivation and improving their skills. For the hearing-impaired and deaf, the alternative second-language learning tool SignMT was tested and evaluated in terms of translation accuracy and proven to satisfy users (Ditcharoen et al., 2010). For children with speech impairment and poor motor control, predictive text entry increased the quality of their written work and reduced spelling errors (Newell et al., 1991). In a study on mathematical learning for children with severe learning difficulties, teachers received a video self-instructional course about number games, and teaching methods used in the classroom were evaluated. Teachers’ learning about new methods and testing them in the classroom had a demonstrated impact on students’ progress (McEvoy & McConkey, 1991). Video has also been used for teaching mathematical concepts for a general population including special-needs students (Straker, 1988).

With regard to ICT use for special educational needs, in the late 1980s there were concerns about the widespread implementation of microelectronics education in schools (Thorne, 1987), and an extensive review of projects involving ICT use for special educational needs in the UK found that the majority were focused on assistive peripheral devices (Neilson et al., 1989).

It is important for research and development of ICT-supported learning to follow equity principles in inclusion efforts. Learning-environment research has to be taken into account, and design requirements have to be adopted for the needs of users with disabilities and also people who do not have special needs. Some studies include both learners with special needs and learners who do not have special needs in the experimental research. Woodline, Baptista Nunes and Wright (2008) combined students with and without dyslexia; Mavrou et al. (2010) investigated pairs of disabled and nondisabled pupils; Conti-Ramsden et al. (2010) dealt with participants with specific language impairment and their normally developing peers; Durkin, Conti-Ramsden and Walker (2011) observed adolescents with and without specific language impairment. We have categorised only a small proportion of papers as including both people with special needs and those without them.

Some authors have surveyed the parents of children with special needs to analyse whether the use of computer-supported collaboration facilitates acceptance by peers in inclusive classrooms (Lewis et al., 2005). Wisdom et al. (2007) evaluated whether the US regulations on equal access to education were supported by ICT, or whether ICT caused an accessibility barrier in equalising processes. The main obstacles identified in Northwest US K-12 schools were system-level accessibility policies and a lack of resources for training and implementation. Doyle and Arnedillo-Sánchez (2011) investigated a multimedia-authoring tool to teach social skills, which was implemented for children with autistic spectrum disorders and evaluated as beneficial by parents and teachers. These studies are categorised as mixed and include some other groups of study participants, for example adults with special needs (see, for example, Nicol & Anderson, 2000; Rajendran & Mitchell, 2000).

Papers about learners and teachers mainly deal with primary and/or secondary education. Papers focused only on primary school total 10 contributions (for example Kleemans et al., 2010; Reis et al., 2010), and those about secondary school total 10 contributions (for example Bain & Parkes, 2006; Wisdom et al., 2007). There are four focused on both primary and secondary educational levels (for example Abbott & Cribb, 2001). There is only one contribution dealing with primary, secondary and college education, that of Singleton and Simmons (2001). Two contributions deal with primary, secondary and adult education (Straker, 1988 and Hartley, 2007). Twelve contributions deal with the tertiary educational level, including graduate school (for example Winter & McGhie-Richmond, 2005) and university and college (for example Istenic Starcic, 2010; Ditcharoen et al., 2010).

Studies in early learning report on the use of ICT-supported learning for teaching children language skills and on the effect of computer-supported collaboration on peer acceptance...

Studies about the lifelong use of ICT focus on general support in life for users and involve accessibility of ICT resources. James and Hammersley (1993) reported on testing of ICT solutions for the hearing-impaired, Hartley (1994) investigated designing instructional text for older readers, and Seale (2001) investigated the use of personal web pages for adults with Down syndrome. Studies with adults with severe cognitive disability have reported on the use of computer pictorial instructions to provide support in the job environment (Furniss et al., 2001) and on computer-supported daily organiser application testing (Ager & Aalykke, 2001). For people with acquired brain injury, computer-aided relearning activity has been tested by experiment, with the control group using traditional methods. One paper concludes that computer-aided relearning is efficient and especially well accepted by younger users (Montero, López-Jaquero, Navarro & Sánchez, 2011). In studies with adults with learning disabilities, the use of websites (Aspinall & Hegarty, 2001; Johnson & Hegarty, 2003), the use of ICT as a support for community participation (Parsons et al., 2006a) and the use of ICT for basic skills training (Nicol & Anderson, 2000) were investigated.

Research design
The category of descriptive research design, in which the authors describe, explain, evaluate or investigate a selected problem regarding the use of ICT for people with special needs (for example Seale & Cooper, 2010; Seo & Bryant, 2009), contains the largest number of papers (58). Qualitative studies predominate among those of descriptive research design (for example Cheng & Ye, 2010; Conti-Ramsden et al., 2010): in total there are 48. Quantitative studies (for example Eden & Heiman, 2011; MacKenzie et al., 1970) total seven. Three papers were identified with mixed-methods research design, applying both qualitative and quantitative research approaches (interview and questionnaire) (for example Nevile & Treviranus, 2010). Among qualitative studies, case studies are predominant—in total 17 (for example Doyle & Arnedillo-Sánchez, 2011; Tan & Cheung, 2008). They most frequently use observation and analysis or interviews (for example Lewis et al., 2005). All quantitative studies are surveys using questionnaires (for example Ari & Inan, 2010). Among the descriptive studies, the larger part—18 studies—were conducted on a sample of up to 10 participants (for example Cheng & Ye, 2010; Lewis et al., 2005; Tan & Cheung, 2008). Eight studies were conducted on samples of 10 to 50 participants (for example Ari & Inan, 2010; Seo & Bryant, 2009); five studies were conducted on samples of 200 to 500 participants (for example Wisdom et al., 2007). Three quantitative studies covered samples of over 100 participants (for example Abbott & CriBB, 2001; Lewis & Neill, 2001), two covered samples of 50 to 100 participants (for example Dincyürek, Arsan & Çağlar, 2011), one study had 127 participants (Conti-Ramsden et al., 2010) and one had between 500 and 1000 participants (MacKenzie et al., 1970).

There are in total 31 papers in the category of developmental research design, and they present design and development of ICT solutions for students with special needs (for example Brown et al., 2011; Rosas, Nussbaum, Strasser & Csaszar, 1997). Predominant are qualitative studies (for example Lin, 2007), in total 26, using interviews (for example Gabrielli et al., 2006), review of journals (for example Istenic Starcic, 2010) and forum discussions (for example MacCann, 2001).
There are six case studies (for example Mavrou et al, 2010) and three surveys based on questionnaires (for example Istenic Starcic & Niskala, 2010; Sheehy, 2005). In this category, the majority of studies were conducted on a sample of up to 10 participants (for example Liu & Hong, 2007; Mavrou et al, 2010) or 10 to 50 participants (for example Hegarty et al, 2000; Istenic Starcic, 2010). Two studies used samples of between 200 and 500 participants (Istenic Starcic & Niskala, 2010; Singleton & Simmons, 2001).

The category of experimental research design (for example Hertzog et al, 1989; Shamir & Shlafer, 2011) contains papers about experiments with experimental and control groups. In total there are 21 papers, which all used the quantitative research approach, conducting pre- and posttreatment tests (for example Kleemans et al, 2010) or interviews (for example Straker, 1988). Among the experimental studies, nine studies had a sample group consisting of 10 to 50 participants (for example Kleemans et al, 2010; Mioduser et al, 2000). Four papers used sample groups of 50 to 100 participants (for example Durkin et al, 2011; Houghton et al, 2004). Four papers used samples of 100 to 200 participants (for example Botte et al, 2009; Shamir & Shlafer, 2011), two papers described samples of up to 10 participants (for example Rajendran & Mitchell, 2000), and one study used a sample of between 200 and 500 participants (Guat & Teh, 1987).

The category of developmental and experimental research design contains eight papers, presenting testing of newly designed and developed ICT solutions through experiments with experimental and control groups (for example Sheehy, 2005; Yang & Lay, 2005). Six studies are quantitative, using observation and analysis. Two studies combine quantitative and qualitative approaches, using questionnaires as well as experiments (Walker & Rostron, 1999; Yang et al, 2007). In this category, four studies were conducted with samples of 10 to 50 participants (for example Ortega-Tudela & Gómez-Ariz, 2006; Yang et al, 2007), three with 10 participants (for example Sheehy, 2005) and one with a sample of 98 participants (Ditcharoen et al, 2010).

Inclusion and mainstreaming
In the 1970s, when the majority of children with disabilities were still educated in special institutions, ideas of integration and inclusion started to appear. Education of students with special educational needs must take place within the mainstream (Opara, 2007), with children enrolled full-time in their neighbourhood schools and communities (Tan & Cheung, 2008). While the first paper on special-education reform was published in 1968 by Dunn (Lindsay, 2007), it was not until the late 1980s that two contributions appeared in the journals of educational technology in which we recognise the beginnings of inclusion. Guat and Teh (1987) did a case study with control and experimental classes exploring the performance of instructional objectives as a learning aid with pupils who are academically less able and who require high levels of guidance and support. One year later Straker (1988) published a quantitative study on the effects of the use of interactive video in teaching students in mainstream schools who have special educational needs and are mildly handicapped.

Papers directly addressing inclusion began appearing in 2001. BJET published a special issue on ICT for people with special needs in the year 2001 (Volume 32, Number 3), highlighting inclusion in ICT-supported learning for people with special needs.

Five dominant themes emerged from the review of papers on inclusion. According to Ralph (2006) and Florian (2003), the five themes illustrate the use of ICT for transformation of teaching and learning to provide equity for and facilitate inclusion of people with special needs in mainstream classrooms and society. Lindsay (2007) proposes the evaluation of learning outcomes and the learning process as a means of providing evidence for effective pedagogical practice in inclusive classrooms. The reviewed papers address the teaching and learning process in terms of the themes of planning, learning environment, teaching methods, preparing teachers for inclusive education and accessibility of computer-based resources.
With regard to curriculum planning, authoring tools have been considered; the effectiveness of learning-management systems in providing digital learning environments has been discussed; computer-supported collaborative learning has been investigated as social support to facilitate inclusive classrooms; and accessibility of computer-based resources has been discussed with regard to inclusive education and social engagement. Preparing teachers for inclusive teaching has been considered with respect to computer-supported learning and professional development practices and communities.

Planning and learning environments are discussed with regard to differentiated instruction. From the perspective of curriculum planning and lesson conduction, the use of curriculum-authoring tools has been investigated in facilitating the inclusion of all students in the classroom using different teaching methods (Bain & Parkes, 2006). Learning-management systems have been addressed from two standpoints: that of special design and development for special-needs students with severe learning difficulties (Istenic Starcic & Niskala, 2010), blind students (Freire et al., 2010), and those with social impairment (Bishop, 2003); and that of being designed to ensure accessibility for learners with different accessibility requirements (Luke, 2002). Computer-supported collaborative learning has been investigated as social support to facilitate mainstream inclusion and is reported as enabling this in inclusive classrooms. It facilitates and improves interaction between students with special needs and their peers (Lewis et al., 2005), improves peer acceptance of students with special needs (Tan & Cheung, 2008) and has a positive impact on overall communication and engagement in learning activities in inclusive classroom (Mavrou et al., 2010).

Under the theme of accessibility of computer-based resources in inclusive education and social engagement, papers addressed the issue of accessibility of resources in education and the wider context. The identified subthemes are promotion of inclusion through websites (Abbott & Cribb, 2001), use of ICT to support community participation of people with special needs (Parsons et al., 2006a), accessibility to disability groups with particular needs (Freire et al., 2010; Istenic Starcic & Niskala, 2010) and universal design and accessibility for all (Iorio et al., 2006; Nevile & Treviranus, 2010; Witt & McDermott, 2004). Universal design can significantly support inclusion processes by providing accessibility for all. Witt and McDermott (2004) investigated academic websites’ accessibility on the basis of universal design in the UK. Nevile and Treviranus (2010) focused on interoperability for individual learners’ particular accessibility needs and preferences. Specifications for display, control and content following principles of design for all were discussed. Iorio et al. (2006) investigated design, production and delivery of accessible learning materials for people with disabilities compatible with W3C standard-compliant technologies.

Teachers’ preparation and professional development is discussed with regard to teachers’ attitudes towards and experiences with the use of computers for special-needs education (Lewis & Neill, 2001) and the role of communities of practice and computer conferencing in facilitating discussion and reflection among teacher–practitioners (Wearmouth et al., 2004; Winter & McHie-Richmond, 2005). Approaches to teacher education and training, including ICT-supported learning environments that enable inclusion and differentiated instruction in inclusive classes, were developed and presented by Istenic Starcic (2010). The SEVERI e-learning environment for special-needs pupils enables student teachers to plan and implement the innovative use of ICT in teaching and develops their ICT competences for inclusive education.

Conclusion
The purpose of this paper is to review and analyse research papers published in the field of ICT-supported learning for people with special needs. Based on a search in ISI Web of Knowledge it was found that the topic has not been extensively investigated, with a total of 118 papers identified; and that the relevant papers are largely in educational technology and ICT-supported
learning journals. An analysis of all topics published in the five educational technology journals *BJET, CE, JCAL, ETR&D* and *ETS* from 2000 to 2009 also revealed that ICT-supported learning of special needs was the least-published research topic among all published topics (Hsu *et al.*, 2012). This review of publications in selected journals over the last 41 years (1970–2011) contributes to knowledge in the rapidly developing field of how educational technology establishes ICT-supported learning environments for special needs and contributes to inclusion. The main finding of the review is that the vast majority of papers published look at specific disability groups or mixes of disabilities, with most papers published on learning disability. Further, the main conclusions concern two issues: the role of ICT in inclusion and the design of pedagogical and technological interventions. The two issues identified have not been sufficiently addressed, and this needs to be resolved by addressing them in future studies.

Our review found a number of papers covering different areas of disability or a combination of disability areas, with most of these papers covering learning difficulties or disabilities. This is in contrast with the findings of Williams, Hamid, Jamali and Nicholas (2006), who, in an extensive review of publications, identified a lack of usability studies for ICT users with learning disabilities and concluded that students with learning disabilities are disadvantaged in this respect in comparison with other disability groups.

The review addresses questions about the role of ICT for inclusion of people with special needs in mainstream education in order to raise broader issues of their inclusion in modern society. The design of inclusive learning environments using teaching and learning approaches (for example differentiated instruction) intended to support inclusion processes is one of the main issues in contemporary mainstream education and society, especially because inclusion processes have been inconclusive (Lindsay, 2007). Teaching and learning approaches for inclusive learning environments can be facilitated by educational technology and ICT, fostering the process of inclusion in education (Florian, 2003; Ralph, 2006). Papers on this issue began to appear in 2001, with a total of 17 papers categorised in this group. ICT-assisted learning is becoming important in formal educational settings, in nonformal settings and in general support for life. Especially for students with disabilities, ICT provides accessibility and equal engagement and facilitates overcoming of potential isolation by connecting them to social environments and enabling their participation in education and wider society.

ICT pedagogical and technological interventions were considered as to whether they support particular needs of users within specific disability groups or are designed for all users, addressing various needs and preferences and including students with special requirements according to their disability. Papers mainly investigate ICT-supported learning with regard to particular disability groups. Only a few papers, published after the year 2000, address universal design. Universal design principles can make a significant contribution to the support of inclusion processes, providing accessibility of resources and processes for all. In instructional design, they facilitate accessibility for all with regard to learning resources and processes (engagement in learning activities and communication with teachers). Students with different accessibility requirements should have the possibility of equal engagement in learning environments. Studies in ICT-supported learning need to address all students—those with special needs and those who do not have special needs. If they are to foster inclusive processes in education they could, for example, investigate how students with different requirements use the same learning environment, or attitudes and experiences of students with different requirements in ICT use in learning or free-time activities. Studies have determined that universally designed environments that include solutions for special requirements can be beneficial for general users. Examples include instructional design solutions for students with learning difficulties (guided instruction, learning-strategy support, supplementary learning material, varying test formats) that have been proven to be beneficial for all students (Silver *et al.*, 1998).
The review brings together information from publications in seven major educational technology journals, providing insight for researchers from various fields into the field of ICT-assisted learning in order to promote investigation and design on the basis of a universal-design-facilitated range of educational and access requirements, thus providing accessibility and facilitating inclusion for all.

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ICT-supported learning for special needs


