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Effects of intensive use of computers in secondary school on gender differences in attitudes towards ICT: A systematic review

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Abstract There is a wealth of interventions focusing on the intensive use of computers in secondary schools, largely aiming at improving students' performance. However, global evidence on the effects of the use of computers on attitudinal outcomes has not been synthesised so far. Taking into account that the differences in the attitudes of boys and girls regarding the use of computers are one of the factors described as causes of the low number of girls following ICT studies, the aim of this article is to review the evidence on the effects of intensive use of computers in schools on gender differences in attitudes outcomes: anxiety, enjoyment, self-confidence and self-efficacy. Searches generated a total of 740 citations of which 59 were identified as relevant and nine were finally included. The methodological quality of included studies was poor to moderate. The results suggest that despite the intensive use of computers, boys are favoured in computer anxiety, self-confidence and self-efficacy; and suggest no differences in computer enjoyment. There is no evidence that intensive use of computers reduce gender differences in these outcomes. Further policy recommendations should be rooted on robust evaluations, which take into account implementations parameters, as well.

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1 Introduction

1.1 Background

The number of girls enrolled in technological fields, especially those related to Information and Communication Technology (ICT) is much less than the number of boys. According to the Organisation for Economic Co-operation and Development (OECD 2015), the average percentage of women holding a Bachelor or equivalent qualification level in the field of ICT (International Standard Classification of Education, ISCED2011 level 6) across all member countries is 19.1%. The three countries with the highest proportion of women having completed Information Technology (IT) superior studies are Colombia (69.6%), Mexico (39.9%) and Greece (36.6%). Some countries below the OECD average are: the USA (17.8%), Spain (17.0%) and with the lowest percentage: Switzerland (6.8%) and Belgium (6.0%).

Schreiner and Sjøberg (2010), coordinators of the ROSE Project (Relevance Of Science Education), provided further evidence on this imbalance. The ROSE project is based on a survey involving 40,000 fifteen years old students from 40 countries carried out between the years 2003 and 2006. To the question asking students about their intention to develop their professional future in the field of ICT, around 50% of European boys responded that they were interested in jobs related to technology, but only 20% of girls did so.

The low presence of women in jobs related to ICT is partially the result of this low enrolment in technological careers. Furthermore, data on European ICT jobs uptake from the report e-Skills Manifesto (Tapscott 2012) showed that 32.7% and 31.6% of people working in ICT related jobs were women in 2008 and 2010, respectively, suggesting a slight decrease over a two years period.

1.2 Factors related to gender differences

There is an extensive research on which might be the reasons why girls do not feel attracted to ICT studies or why they do not think about their future career in this field. These factors can be included in three categories: families and teachers influence, professional stereotypes and personal attitudes.

1.2.1 Families and teachers influence

Some studies (Sáinz and López-Sáez 2010; Sáinz et al. 2012; Stockdale and Keane 2016) suggest factors such as the influence of families and teachers or the lack of female role models in the field of ICT (Carrington et al. 2008).

Sáinz et al. (2012) carried out their study targeting parents and teachers of secondary schools in Catalonia in order to examine parents' and teachers' opinions about male and female career and occupational aspirations. The authors used a focus discussion (four with parents and three with secondary teachers) to explore perceptions of both

groups about ICT professionals and gender differences in professional choice. The authors conclude that parents (particularly mothers) tend to view ICT professionals in a generally negative manner, as individualistic people, lacking social skills. The authors suggest that it is hard to believe that those parents would encourage their daughters to pursue an ICT career. In the same way, teachers tend to understand ICT as a typically male field. This means that the attention given to boys and girls in the classroom is likely biased and that any career advice given to students would also be stereotyped.

Stockdale and Keane (2016) carried out a pilot study targeting mothers of school children in Australia in order to change their views about ICT as being a non-female field. Mothers were introduced to basic ICT tools and learnt about the scope of ICT careers in order to be aware of future possibilities for their children, especially girls. After the course, their views were recorded and the authors concluded that there was a change on the gendered misconception on ICT careers, suggesting that this could be an effective intervention, at least in the short run.

1.2.2 Professional stereotypes

Other factors include the stereotypical view that girls have about studies and jobs related to ICT and their unfamiliarity about what really means to work in this field (Castaño and Webster 2011; Clayton et al. 2009; Klapwijk and Rommes 2009; Master et al. 2016; Pechtelidis et al. 2015; Schott and Selwym 2000; Thomas and Allen 2006; Von Hellens et al. 2009).

Thomas and Allen (2006) carried out an exploratory research on boys' and girls' perceptions about ICT careers. The survey concluded that girls considered people working on ICT as "geeks", asocial, mostly men and doing a very technical job far from the real social needs. These misconceptions about the real social needs to which technological jobs can contribute seem to auto-exclude girls from ICT careers.

Tipically, these stereotypes are fully embedded in social perceptions about the male nature of ICT related jobs. Accordingly, Cheryan et al. (2013) exposed in their paper how media gave an image of masculinity to this field, which reinforces girls' perceptions.

Some of these factors are also reported in a study by the European Schoolnet consisting on an analysis of different views of high school students, boys and girls, about ICT and their projection as a future profession, in several European countries (Gras-Velazquez et al. 2009).

1.2.3 Personal attitudes

A complementary approach to the gender imbalances is to consider differences on the attitudes strategies in problem solving, learning and use of IT tools (Marcoulides 1988; Varma 2009). These gender differences may influence how boys and girls face the use of ICT or consider following computer-related careers and jobs, in their academic or professional life (Colley and Comber 2003; Kubiatko 2013; Volman et al. 2005).

Girls' attitude in the use of ICT is slightly lower than boys' (Adebowale et al. 2009; Busch 1995; Chen 1986; Shashaani 1993; Volman and van Eck 2001). Attitudes toward computer can been classified in different dimensions, anxiety, enjoyment and self-confidence (Delcourt and Kinzie 1993; Loyd and Gressard 1984; Spanos and Sofos 2015). Some authors add other subcategories like utility of computers (Pelton and Pelton

1996) and cognition (Kay 1993) as the self-perception of skills to do some specific tasks using computers. This one can be assimilated to self-efficacy.

Anxiety is defined as fear to interact with ICT and showing overall negative attitudes towards ICT, which leads to a deterioration of tasks and their accomplishment (Shashaani 1993). In relation to anxiety, there is a disparity of findings among different authors. Some of them (Teo 2008) found no differences between boys and girls, while others (Adebowale et al. 2009; Baloğlu and Çevik 2008; Kaino 2008; Kubiatko et al. 2011) report higher anxiety in girls as compared with boys.

The dimension of enjoyment refers to the interest in the use of ICT, not only within the academic context of schools but also during leisure time (Shashaani 1993). The level of enjoyment has been widely reported as being similar for boys and girls (Adebowale et al. 2009; Fančovičová and Prokop 2008; Kaino 2008; Teo 2008). However, Fraillon et al. (2014) pointed at higher levels of enjoyment in boys than in girls and Kubiatko et al. (2011) suggested the opposite. A factor that could explain these differences between studies may be the differences in ages in the samples of subjects included and differences in the use of computers in schools and at home.

Perceived personal control of ICT tools corresponds to the dimension of self-confidence, and includes feeling comfortable when using them and feeling able to overcome difficulties by one's own means (Shashaani 1993). This dimension is consistently lower in girls (Christoph et al. 2015; Volman and van Eck 2001). Boys tend to perceive themselves as 'experts' in ICT, while girls seem to perceive themselves as less skilful and with less knowledge (Volman and van Eck 2001). The low self-confidence in girls seems to be associated with girls' tendency to undervalue them, boosted by informal self-learning (Volman and van Eck 2001).

Finally, self-efficacy is defined as the belief in the ability of oneself to successfully carry out some actions (Busch 1995) and is typically measured by estimating the number of tasks that an individual wants to accomplish believing that he or she is not able to complete, and the number of tasks that the individual considers that he or she can perform without problems. Self-efficacy may affect not only the degree of success in accomplishing tasks using computers but not to consider pursuing and ICT career (Galpin and Sanders 2007).

1.3 Objectives of the review

As described in the introduction section, there are three main groups of factors influencing gender differences on ICT: families and teachers, professional stereotypes, and personal attitudes. Attitudes may be the most vulnerable to interventions carried out in school settings, where interventions can be more feasibly implemented with a potentially greater impact on students.

It has been hypothesised that the systematic use of computers in schools could reduce gender differences in attitudes and self-efficacy (Downey and Kher 2015; Blignaut 2006; Teo and Noyes 2008). In the recent years, the use of computers in schools has increased and initiatives, such as one-to-one programmes (intensive computer use facilitated by the fact that each pupil has his/her own computer as a fundamental learning tool) or intensive use of computers in all subjects, have been adopted in a large number of countries. Evaluations of the effects of these initiatives have focused on students' achievements, on closing the digital divide between students

with different economic backgrounds, on changes over methodological practices or on implementation issues (Bebell and Kay 2010; Shapley et al. 2009; Silvernail and Gritter 2007). These evaluations do not disaggregate the observed effects by gender.

However, there is overwhelming evidence suggesting that gender differences persist, which urges for an evaluation of these interventions from a gender perspective.

There are four systematic literature reviews on the effects of one-to-one initiatives (Fleischer 2012; Harper and Milman 2016; Islam and Grönlund 2016; Penuel 2006), which report on estimates of pupils' learning performance and teachers' tasks. However, none of these reviews report on gender differences or on outcomes related to attitudes towards ICT.

Hence, the focus of our literature review is on school settings and attitudes (anxiety, enjoyment, self-confidence) and self-efficacy outcomes.

We aim at addressing two research questions through a systematic literature review:

1. What are the effects of the intensive use of computers on gender differences in attitudes and self-efficacy, in secondary schools settings?
2. Does current evidence provide insights on other factors that can influence these differences and to what extent?

2 Methods

This systematic review is reported following the systematic reviews standard reporting conventions described in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Moher et al. 2009) and the inclusion criteria follow the PICOTS strategy (Population, Intervention, Comparator, Outcomes, Times, Study design).

2.1 Study inclusion criteria

2.1.1 Types of participants

Participants should be students, boys and girls, from 12 to 18 years old (i.e. equivalent to secondary education), enrolled in schools, without distinction of funding type (e.g. public or private schools), location (e.g. rural, urban) or educational style. We have decided to focalise the review at secondary education because at this level the intensive use of computers is more extensive than in primary schools.

2.1.2 Types of interventions

We have considered interventions consisting in the intensive use of computer devices (e.g. laptops, personal computers (PC) or tablets) in the classrooms within school hours. Mobile phones were excluded.

The interventions consist on the use of one-to-one programmes (i.e. one device for each student) or shared devices among pupils, to carry out classroom activities using digital tools (e.g. collaborative tools to create documents, simulators, virtual learning environments, digital books).

Intensive use of computers refers to an inclusive and daily use in all or almost all of school topics or subjects, where computers are used "transparently" as a standardized

resource within the classroom's own dynamics. However, computer use complexity may vary from routine use for daily tasks to more comprehensive use when ICT itself is the learning activity.

We have included interventions with more than one school enrolled.

2.1.3 Types of outcomes

There is a wide range of different validated scales to measure attitudes towards the use of computers. For example, Shaft et al. (2004) reported 31 different instruments since the year 1966.

The Computer Attitude Scale (CAS), developed by Loyd and Gressard (1984), is one of the most used in the literature and it has been validated in different settings (Francis 1994; Selwyn 1997; Blignaut 2006; Powell 2013). The CAS scale has 30 item groups in three sub-scales corresponding to the three attitude's dimensions: anxiety, enjoyment and self-confidence. Statements are mixed and not structured around domains. Each item corresponds to a phrase on what students must indicate to what extent (from 1 to 5) they agree. Five questions in each domain are formulated in a negative sense to minimize automatic answering and to stimulate a careful reading of the questions. Some examples of these questions are: Working with a computer would make me very nervous (anxiety); Once I start to work with the computer, I would find it hard to stop (enjoyment); Generally, I would feel OK about trying a new problem on the computer (self-confidence).

In this review we have considered the outcomes of interest as defined in the CAS: anxiety, enjoyment and self-confidence, adding self-efficacy along with the study of Kay (1993).

These outcomes are separately reported by gender or reported as gender differentials.

2.1.4 Range of studies

We have screened studies published in peer-reviewed journals and also grey literature (i.e. reports, dissertations, proceedings) between 2005 and 2015. Articles before the year 2005 were excluded because intensive use of computers was hardly introduced in schools before these dates.

2.1.5 Types of studies

Experimental, quasi-experimental and observational studies, or mixed methods studies with quantitative estimates.

Although the capacity of observational and mixed methods studies to report effect estimates is limited, we decided to include them as well anticipating a small amount of experimental and quasi-experimental studies.

2.1.6 Types of instruments

We have considered studies using validated scales and instruments. These instruments can have been validated in previous studies or the authors have justified the process of validation when the instrument has been created specifically for the study.

2.2 Search strategy

We developed a comprehensive search strategy, which was adapted to each literature database. Search terms included: computer, ICT, gender, attitude, self-efficacy, anxiety, education, secondary and high school, and their synonymous terms (see Appendix 1 for search terms).

The following literature sources were searched: TESEO, DART-Europe, ERIC, Taylor and Francis, SAGE and Science Direct. Considering the speedy evolution of IT and their use in the last years, it seems reasonable to restrict the search to the last 10 years.

References of included studies were manually scrutinised in order to detect potentially relevant studies. Articles known to the authors of this review were also considered for inclusion.

2.3 Selection of studies

All articles were codified according to their source and stored in a conventional reference manager application. Duplicates were identified and removed.

A single author scrutinised titles and abstracts for relevance being rather inclusive in the decisions. Full texts of relevant articles were retrieved to apply the inclusions criteria, using a coded spreadsheet to record compliance of each study with each inclusion criteria that was piloted in a sample of articles to ensure consistency and accuracy. The main author applied these criteria to maximise inclusion (i.e. no study was excluded if there was an unclear assessment). Studies with unclear assessments were discussed with a senior research fellow and agreement was achieved by consensus.

Although single reviewer study selection is prone to bias, there seem to be an acceptable alternative if mitigation measures are in place (e.g. piloting the inclusion criteria in a small sample of studies).

Findings from included studies are reported below; and excluded studies and reasons for exclusion are listed in Table 6 in Appendix 2.

2.4 Data extraction

The following data items were extracted from the articles included in the present study: first author name, journal, year of publication, educational systems setting, age of participants, sample size, number of schools included, subjects or topics where computers are used, outcomes, quantitative instrument used, qualitative instruments, times of intervention and methodologies applied (see Table 1).

Estimates have been extracted and are reported as found in the articles, including precisions estimates when available (e.g. standard deviation (SD), standard error (SE) or confidence intervals (CI)).

The methodological quality of the studies has been assessed using the checklist of the Critical Appraisal Skills Programme (CASP), adapted to the study designs included in this review. The Better Value Healthcare, a training organisation whose objective is to develop tools for critical appraisal to quality research, has created this tool.

Table 1 Characteristics of the included studies (sorted by type of outcome)

Author, year and country	Type schools	Number schools	Sample size (age)	Subjects or topics	Outcomes type	Outcomes detail	Instruments	Times	Qualitative[b]
Baloğlu and Çevik (2008) Turkey	Not indicated	Not indicated	715 (14 to 19)	Computer course	Anxiety	Ownership Frequency of computer use	CAS scale	1	No
Kaino (2008) Botswana	Not indicated	10	72 (12 to 15)	Diverse[a]	Anxiety Enjoyment	Usefulness of using computers in learning Student's comfort Types of learning	Ad hoc	1	Close open-ended questions in interviews
Kubiatko et al. (2011) Slovakia	Not indicated	14	659 (14 to 19)	All subjects use ICT	Anxiety Enjoyment	Age	CAQ scale	4	No
Teo (2008) Singapore	Not indicated	1	183 (18)	ICT subjects	Anxiety Enjoyment	Computer importance Ownership	CAQ adapted	1	No
Fančovičová and Prokop (2008) Slovakia	Not indicated	4	214 (10 to 14)	Diverse[a]	Enjoyment	Frequency of computer use Types of use	ATICTQ scale	1	No
Papastergiou (2008) Greece	State	5	358 (17 to 18)	Diverse[a]	Self-efficacy	Intention to pursue studies in ICT Perception of ICT professions Frequency of use Family ICT skills Teacher' role	Ad hoc	1	Questions included in questionnaire
Vekiri (2010) Greece	Not indicated	4	301 (12 to 16)	Diverse[a]	Self-efficacy	Value beliefs Perceived parental support Perceived teacher expectations	Ad hoc	1	No

Table 1 (continued)

Author, year and country	Type schools	Number schools	Sample size (age)	Subjects or topics	Outcomes type	Outcomes detail	Instruments	Times	Qualitative[b]
Christoph et al. (2015) Germany	Not indicated	4	445 (14 to 17)	Not indicated	Computer self-concept	Computer interest ICT engagement Basic computer skills Computer knowledge	Ad hoc	1	No
Downes and Looker (2011) Australia	Not indicated	11	722 (15)	ICT subjects	Perceived ability	Plans to take ICT subjects Attitudes toward ICT subjects Frequency of use Parental education	Ad hoc	1	42 discussion groups

[a] The term "Diverse" in column "Subjects or topics" is referred to the use of computers in ICT subjects and other subjects not specified

[b] "Qualitative" column indicates whether studies reported qualitative findings as well, besides quantitative estimates

2.5 Data analysis

The variety of study designs, outcomes reported and measurement methods precluded any attempt to use meta-analytical methods. We have calculated the effect size as ratios of means where disaggregated means for boys and girls were reported; and as relative risks where proportions of boys and girls presenting a given feature were reported. 95% confidence intervals were calculated if the sample sizes by gender were available and, for means, if standard deviations or standard errors were reported. We estimated effect sizes by subgroups where data was available in the studies (see Table 3).

Given the disparity of outcomes, we did not attempt to carry out meta-analyses of the effects; instead, we present narrative syntheses of the effects for each outcome. Quantitative analyses were carried out in R for Windows, version 3.2.2.

3 Results

The databases searches generated a total of 740 citations (see Appendix 1, Table 5) 59 studies were identified as relevant and nine were finally included based on our inclusion criteria (see Appendix 3, Table 7). The study flow diagram is shown in Fig. 1 and reasons for exclusion are listed in Appendix 2, Table 6.

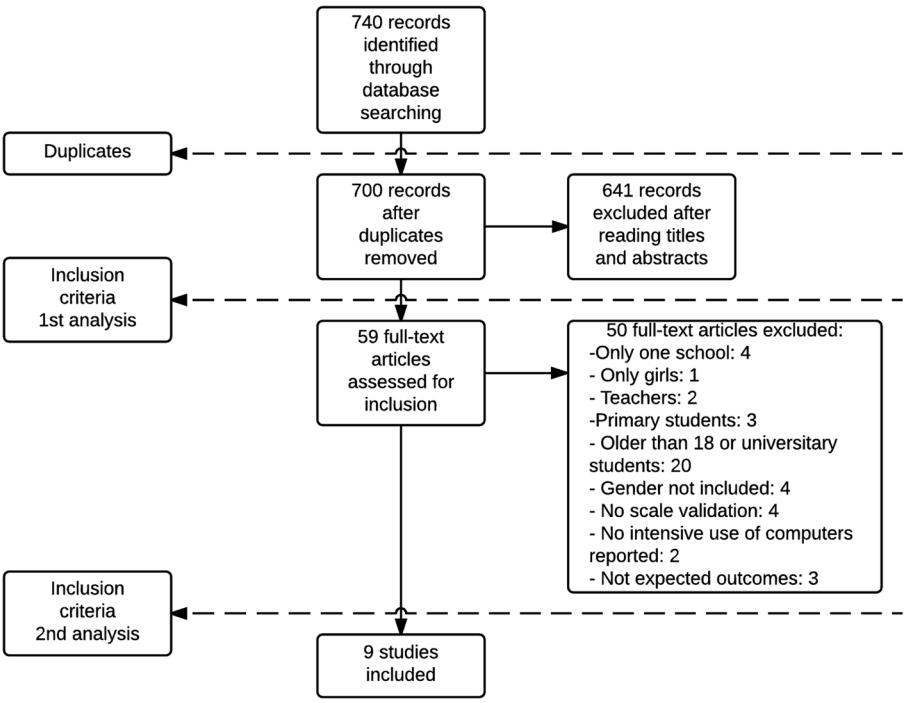

Fig. 1 Study flow diagram

3.1 Description of included studies

All nine studies were cross-sectional studies. Three of them used mixed methods: questionnaires with open questions (Papastergiou 2008), structured interviews with close- and open-ended questions (Kaino 2008) or discussion groups (Downes and Looker 2011).

The years of the publication of the studies ranged from 2008 to 2015. Five of the nine studies are from 2008 (Baloğlu and Çevik 2008; Fančovičová and Prokop 2008; Kaino 2008; Papastergiou 2008; Teo 2008), one study is from 2010 (Vekiri 2010), two of them are from 2011 (Downes and Looker 2011; Kubiatko et al. 2011), and one study is from 2015 (Christoph et al. 2015).

The countries where interventions were assessed were: Australia (Downes and Looker 2011), Botswana (Kaino 2008), Germany (Christoph et al. 2015), Greece (two studies: Papastergiou 2008; Vekiri 2010), Singapore (Teo 2008), Slovakia (two studies: Fančovičová and Prokop 2008; Kubiatko et al. 2011) and Turkey (Baloğlu and Çevik 2008).

The descriptors for each study are shown in Table 1.

Tools to measure outcomes consisted of questionnaires, which varied from those developed specifically for the study to standardized or validated scales widely used, with or without modifications. Standard scales used were: Computer Attitude Scale (CAS) (Baloğlu and Çevik 2008), Attitudes Toward ICT Questionnaire (ATICTQ) (Fančovičová and Prokop 2008) and Computer Attitude Questionnaire (CAQ) (Kubiatko et al. 2011; Teo 2008). The remaining five studies applied ad hoc questionnaires without indications on how where they developed or whether they were validated or not.

The number of schools included in the studies varied from 4 (Christoph et al. 2015; Fančovičová and Prokop 2008) to 14 (Kubiatko et al. 2011). Schools selection was randomised only in one study (Papastergiou 2008). In the rest of studies, selection was purposive considering all schools in a given geographical area (Downes and Looker 2011), or according to certain schools features albeit these were not further detailed (Kubiatko et al. 2011; Vekiri 2010); or more often, the selection process was not reported (Baloğlu and Çevik 2008; Christoph et al. 2015; Fančovičová and Prokop 2008; Kaino 2008; Teo 2008).

It is relevant that the type of participating schools according to their funding source was only reported in one study being state schools (Papastergiou 2008). In two studies, it was stated that the education administration collaborated with the researchers, either providing data (Downes and Looker 2011) or as being part of the study (Christoph et al. 2015).

The number of students enrolled in the studies varied from 72 (Kaino 2008) to 722 (Downes and Looker 2011). The selection of students within schools was randomised in one study (Kaino 2008), in three studies (Christoph et al. 2015; Downes and Looker 2011; Papastergiou 2008) all students in selected schools were included and in another study students participated on a voluntary basis (Teo 2008).

The age range of students participating in the studies was 10 to 19 years old. All students attended secondary schools, including both compulsory and post-compulsory education. Education levels had different age ranges, depending on the country.

Interventions are related to the intensive use of computers in classrooms in all school subjects. This means that students use computers as a frequent tool for learning and creating digital content. However, all authors stated that the actual use of computers in most of the schools was much lower than what is suggested in education policies.

Studies do not differentiate between schools running one-to-one models and schools where computers are used in the IT or other classrooms. The intensity in the use of computers varied across the included studies. This variation mimics real-life situations where these types of interventions may be applied differently across contexts, which increase the relevance of this review for concrete settings. We have taken into account this variability, where reported, in the interpretation of our findings.

None of the studies assessed interventions based on tablets or mobile phones.

Outcomes definitions differed among studies. For example, anxiety was defined slightly differently (Baloğlu and Çevik 2008; Kaino 2008; Kubiatko et al. 2011; Teo 2008) as we will detail when reporting the outcomes below.

All studies but Kubiatko et al. (2011) measured outcomes only once. In these authors' study, outcomes were separately measured in four levels in the same academic year in order to obtain age-specific estimates.

Some studies looked at the association between outcomes and certain factors, such as family factors (e.g. parental education, expectations in relation to the offspring), teachers (e.g. gender, expectations related to students), use of computers at home (e.g. ownership, frequency of use, types of use), expectations related to ICT (e.g. continuity in the studies, professional projection, interest in ICT subjects, knowledge about professions), ability in the use of computers (e.g. basic digital skills, advance IT knowledge) or factors related to the influence of the use of computers in the learning processes.

3.2 Methodological quality of studies

The methodological quality of the studies has been assessed using the checklist of the Critical Appraisal Skills Programme (CASP), adapted to the study designs included in this review.

Quality criteria were applied (in brackets, number of studies which successfully rated in each criteria): studies addressed a clearly focused issue (7), participants were recruited in an acceptable way (2), outcomes were accurately measured to minimise bias (4), authors identified important confounding factors (4), authors had taken into confounding factors in the design and/or analyses (4), follow up of subjects was complete enough (4), results were consistent with the objectives (7), results were precise (6), results were considered as reliable (6), results seemed applicable to several contexts (1), results fitted with other available evidence (6), and results provided robust evidence for recommendations to policy and practice (7). Additional criteria included specifying that consent had been requested to subjects (1), sample sizes calculations (0) and analytical methods description and appropriateness (6). It is worthwhile noting that none of the studies indicated how the sample size was estimated and that in only two studies the selection of participants was at random.

Compliance with the quality criteria by study is shown in Table 2. Interestingly, five of the nine studies complied with less than half criteria, and the best quality studies did not reach three quarters of the criteria.

3.3 Outcome computer anxiety

The definitions of anxiety varied between studies. Baloğlu and Çevik (2008) established three components related to Computer Anxiety: Affective Anxiety, referring to negative

Table 2 Results of the quality of studies included in the review

CASP items (CASP Cohort Study Checklist)	Baloğlu and Çevik (2008)	Christoph et al. (2015)	Downes and Looker (2011)	Fančovičová and Prokop (2008)	Kaino (2008)	Kubiatko et al. (2011)	Papastergiou (2008)	Teo (2008)	Vekiri (2010)
The study addressed a clearly focused issue	Y	Y	Y	Unclear	Y	Y	Y	Y	Unclear
The cohort was recruited in an acceptable way	Unclear	Unclear	Unclear	Unclear	Y	Unclear	Y	N	N
The outcome was accurately measured to minimise bias	Y	Y	Unclear	N	N	Y	Y	Unclear	N
The authors have identified all important confounding factors	Y	Y	Y	N	N	Y	Unclear	N	Unclear
The authors have taken account of the confounding factors in the design and/or analysis	Y	Y	Y	N	N	Y	Unclear	N	Unclear
The follow up of subjects was complete enough	Y	Unclear	Unclear	Unclear	Unclear	Y	Y	Y	Unclear
The follow up of subjects was long enough	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
The results are consistent with the objectives	Y	Y	Y	Unclear	Y	Y	Y	Y	Unclear
The results are precise (CI/SD/SE)	Y	Y	N	Y	N	N	Y	Y	Y
Do you believe the results?	Y	Y	Y	Unclear	Unclear	Y	Y	Unclear	Y
The results can be applied to several contexts	N	N	N	N	N	N	N	N	Y
The results of this study fit with other available evidence	Y	Y	Y	N	Unclear	Y	Y	N	Y
Are there implications for practice or policy?	N	N	Y	Y	Y	Y	Y	Y	Y
Additional criteria									
Consent of subjects	Y	N	N	N	N	N	N	N	N
Sample size estimate reported	N	N	N	N	N	N	N	N	N
Analytical methods described and appropriate	Y	Y	Unclear	Unclear	Unclear	Y	Y	Y	Y
Summary									
Y	73%	60%	47%	13%	27%	67%	67%	40%	40%
Unclear	7%	13%	27%	40%	27%	7%	13%	13%	33%
N	20%	27%	27%	47%	47%	27%	20%	47%	27%

emotions toward computers, Damaging Anxiety, referring to the fear of damaging computers and/or to the work being done on computers, and Learning Anxiety, referring to the fear of learning computers or computer applications. In the study of Kaino (2008), anxiety is the state of comfort or confusion related to computers use, whereas Kubiatko et al. (2011) defined anxiety as the fear in the use of computers. Finally, in Teo (2008) anxiety is defined as the lack of confidence in the use of computers.

Baloğlu and Çevik (2008) suggested that girls showed more anxiety than boys in all components of anxiety. The difference between boys and girls was higher in Learning Anxiety (low means mean low anxiety and vice versa) (boys: 10.39, SD 3.03; girls: 11.06, SD 3.20) and lower in Affective Anxiety (boys: 17.22, SD 4.63; girls: 18.48, SD 6.20).

Kaino (2008) differentiated between students' concerns in computer learning and students' anxiety in computers use, similarly to the Learning Anxiety and Affective Anxiety found in Baloğlu and Çevik (2008), respectively. The findings were similar: in Kaino (2008), the largest difference between boys and girls was found in Learning Anxiety (higher percentages meaning lower anxiety) (boys: 61%; girls: 33%) and to a lesser extent in Affective Anxiety (boys: 76%; girls: 50%).

Similarly, Kubiatko et al. (2011) suggested differences in mean anxiety between boys and girls (high values mean low anxiety) (boys: 3.93 and girls: 3.61).

In Teo's study (2008) there was no significant difference in mean anxiety between genders (higher values meaning lower anxiety) (boys: 3.93; girls: 3.61), despite that the mean for girls was lower than the one for boys. The study suggested that increasing access to computers owned by students could explain the relative similarities in anxiety between genders.

Some authors have reported factors decreasing anxiety, such as ownership of computer (Baloğlu and Çevik 2008; Teo 2008); high frequency of use of computers (Baloğlu and Çevik 2008; Kaino 2008); younger age of students (Kubiatko et al. 2011); and collaborative learning methodologies (Kaino 2008). Only Baloğlu and Çevik (2008) reported data disaggregated by gender (see Table 3) suggesting that anxiety decreased when taking into account ownership of computers and frequency of use, particularly in girls and for Affective Anxiety.

In summary, most of the evidence suggests that gender differences in anxiety seem to be reduced by the intensive use of computers (high risk of bias).

3.4 Outcome computer enjoyment

Fančovičová and Prokop (2008) reported on attitudes related to ICT measured with the ATICTQ scale, which has three dimensions: behavioural, cognitive and affective. The study showed no gender differences in the mean of the affective dimension that is equivalent to the term of enjoyment.

Kaino (2008) suggested that boys and girls showed similar levels of enjoyment in the use of computers (boys: 86%; girls: 84%) and in their views on the utility of computers in several situations (e.g. job seeking, access to information).

Findings in Teo (2008), reported as mean enjoyment, were similar to those of Kaino (2008): (boys: 3.74, SD 0.69; girls: 3.58, SD 0.66).

Kubiatko et al. (2011) showed somehow different findings suggesting that enjoyment in the use of computers among girls was higher than among boys (boys: 3.95;

Table 3 Findings of the review by type of outcome and study, disaggregated by gender

Outcomes	Authors	Dimensions	Type of estimate	Boys	SD	Girls	SD
Computer anxiety	Baloğlu and Çevik (2008)	Affective Anxiety[1]	Mean	17.22[3]	4.63	18.48[3]	6.20
		Damaging Anxiety		13.11[3]	4.17	15.23[3]	5.76
		Learning Anxiety[2]		10.39[3]	3.03	11.06[3]	3.20
	Kaino (2008)	Student's anxiety in using computers[1]	Percentage	76[4]	NA	50[4]	NA
		Students' worries in learning using computers[2]		61[4]	NA	33[4]	NA
	Kubiatko et al. (2011)	Computer anxiety	Mean	3.93[4]	NA	3.61[4]	NA
	Teo (2008)	Computer anxiety	Mean	4.00[4]	0.79	3.65[4]	0.77
	[1,2]Analogue outcomes [3]Low value means low anxiety [4]High value means low anxiety						
Computer enjoyment	Fančovičová and Prokop (2008)	Behavioural	Mean	35.3	0.49	33.15	0.47
		Cognitive		NA	NA	NA	NA
		Affective[5]		NA	NA	NA	NA
	Kaino (2008)	Enjoyment[6]	Percentage	86	NA	84	NA
	Teo (2008)	Enjoyment[6]	Mean	3.74	0.69	3.58	0.66
	Kubiatko et al. (2011)	Enjoyment[6]	Mean	3.95	NA	4.20	NA
	[5,6]Analogue outcomes						
Computer self-confidence	Christoph et al. (2015)	Computer self-concept vs. computer interest	Regression coefficients	0.62		0.35	
		Computer self-concept vs. ICT related social engagement		0.57		0.36	
		Computer self-concept vs. basic computer skills		0.32		0.29	
		Computer self-concept vs. computer knowledge		0.53		0.33	
Computer self-efficacy	Downes and Looker (2011)	Self-ability: disagree	Percentage	19	NA	31	NA
		Self-ability: neutral		38	NA	43	NA
		Self-ability: agree		44	NA	26	NA
	Papastergiou (2008)	Computer self-efficacy		NA	NA	NA	NA
	Vekiri (2010)	Computer self-efficacy	Mean	5.23	1.29	5.02	1.08
		Female teachers		4.82	1.22	4.82	0.74
		Male teachers		5.36	1.22	4.51	1.08

girls: 4.20) was the only study reporting factors that may influence enjoyment (e.g. age of students), but not disaggregated by gender.

In summary, there is no conclusive evidence supporting any effect of intensive use of computers on computer enjoyment (high risk of bias).

3.5 Outcome computer self-confidence

Christoph et al. (2015) addressed the issue of computer self-concept, which is equivalent to self-confidence to the extent that it involves the self-perceptions of one's own skills in the use of ICT tools. Findings suggested that boys perceived themselves as being more skilful in the use of computers than girls. In addition, regression analyses showed that among boys there was a direct association between self-confidence levels, their basic ICT knowledge and their strong interest in ICT.

Authors suggested that the more intense the use of computers, the higher levels of self-concept, which may be due to the fact that increasing basic ICT knowledge improves the perceptions of skilfulness in the use of computers.

There is some evidence (only one study with high risk of bias) that the intensive use of computers may reduce self-confidence gender differentials.

3.6 Outcome computer self-efficacy

The study of Downes and Looker (2011) estimates self-ability levels, which is equivalent to self-efficacy, measuring the participants' self-perception when carrying out certain activities with computers. The study reported that boys showed higher self-efficacy in school tasks than girls (boys: 44%; girls: 26%). Answers obtained from group discussions were consistent with these findings.

Papastergiou (2008) showed findings somehow similar to those of Downes and Looker (2011): the author reported that self-efficacy among girls was lower than among boys (boys: 37.11, SD 6.64; girls: 32.35, SD 6.61) and she established a positive relation between high scores of self-efficacy and the intention to continue with ICT superior studies.

Vekiri (2010) did not show gender differences in mean self-efficacy levels (boys: 5.23, SD 1.29; girls: 5.02, SD 1.08).

Some authors have reported on factors increasing self-efficacy levels, such as: teachers' roles (Papastergiou 2008; Vekiri 2010); parental support (Vekiri 2010), frequency of use of computers (Downes and Looker 2011; Papastergiou 2008; Vekiri 2010); and specific methodologies (Vekiri 2010). Only Papastergiou (2008) reported gender disaggregated data (see Table 3). In relation to teachers', the author reported that girls having a female teacher showed lower differences on self-efficacy level compared to boys than in classrooms with male teachers. The author concluded that girls were more strongly influenced by teachers' expectations than boys (see Table 3).

Vekiri (2010) reported data related to seven teachers (four females and three males) and reported gender disaggregated self-efficacy levels. Although data are not conclusive, they suggest similar trends than those of Papastergiou (2008): schools have to be a reference for the girls in ICT matters, in order to improve their self-efficacy level through female teachers' models.

Downes and Looker (2011) established correlations between self-efficacy and the intention of students to enrol in ICT studies in the future, but not disaggregated by gender. Findings suggested that students with a high level of self-perceived computer ability were more likely to consider pursuing an ICT career.

There is some evidence (high risk of bias) that the intensive use of computers may reduce self-efficacy gender differentials.

4 Discussion

We have reviewed all available evidence on the effects of the intensive use of computers in schools on students' attitudinal outcomes. We have found only nine studies, none of them experimental and any with optimal methodological quality. The reasons why the methodological quality of studies was generally low is due to the fact that most of the studies were observational, without controls, which limits their capacity to produce unbiased effects estimates.

We acknowledge that complex interventions in the educational sector pose methodological challenges to implement experimental or quasi-experimental study designs, which are appropriate to estimate the effects of interventions. However, there are examples of robust evaluations that suggest that this is possible. We encourage the use of robust designs to evaluate the effects of interventions to better inform policy and practice. Future research should focus on good quality study designs, including comparators and random allocation of study subjects.

Studies suggested that intensive use of computers might reduce gender differences in some outcomes and not in others. As in any intervention, contextual and implementation issues may play a role in the observed effects. Often, these issues are hardly reported. However, we extracted all available data on factors, which might explain the effects or lack of effects (see Table 4). The findings in this review have to be interpreted with caution given the high risk of bias of included studies.

All studies suggested higher anxiety levels on using computers in girls than in boys. These findings are consistent with other studies (Chen 1986; Durndell and Haag 2002; Shashaani 1993). But did studies suggest reasons for gender differences? Included studies provide limited evidence to ascertain whether gender differences in anxiety are related to the interventions, such as the frequency of use (Baloğlu and Çevik 2008; Kaino 2008) or to other factors, such as age (Kubiatko et al. 2011) and ownership of computers (Baloğlu and Çevik 2008; Teo 2008). It seems also reasonable to assume the interventions aiming at increasing the frequency of use may reduce anxiety (Kaino 2008; Baloğlu and Çevik 2008) especially if combined with other measures, which reinforce student's self-confidence in the use of computers. However, the evidence supporting this is weak and inconclusive.

It is worth noting that the definition of anxiety it's not standardized across the studies. Some authors have even defined sub-categories (Baloğlu and Çevik 2008; Kaino 2008). The differences on the meaning of the term of anxiety may be related to the instruments used to measure it in each study. It is paramount to agree on standardized methods for measuring anxiety that would allow a meaningful comparison between studies and meta-analyses of effects estimates.

Table 4 Factors influencing outcomes; bold authors reporting effects

	Anxiety	Enjoyment	Self-confidence	Self-efficacy
Parental support and education				**Vekiri (2010)** Downes and Looker (2011) Papastergiou (2008)
Teacher roles				**Vekiri (2010)** **Papastergiou (2008)**
Ownership	**Teo (2008)** **Baloğlu and Çevik (2008)**			Downes and Looker (2011)
Frequency of use	**Baloğlu and Çevik (2008)** **Kaino (2008)**			**Downes and Looker (2011)** **Papastergiou (2008)**
Age	**Kubiatko et al. (2011)**	**Kubiatko et al. (2011)**		
Expectations related to ICT			**Christoph et al. (2015)**	**Papastergiou (2008)** **Downes and Looker (2011)**
Types of learning	**Kaino (2008)**			**Vekiri (2010)**

No gender differences were reported in two of the three studies reporting the outcome 'enjoyment' (Kaino 2008; Teo 2008); and a third study (Kubiatko et al. 2011) suggests that girls have a larger enjoyment level tan boys, especially at younger ages.

Self-confidence was even lesser reported with only one study (Christoph et al. 2015) which suggested that boys were more self-confident than girls, consistently with other findings as well (Chen 1986; Shashaani 1993). These authors reported effects of frequency of use and positive perceptions on ICT professions on increasing self-confidence levels in both genders.

Self-efficacy seemed to be lower among girls, as already suggested by others (Durndell and Haag 2002; Miura 1987). Again, some evidence suggests that another factors as frequent use of computers, parental support and teachers' roles may increase self-efficacy (Downes and Looker 2011; Papastergiou 2008; Vekiri 2010).

Anxiety and self-efficacy are the most reported outcomes and they are directly linked with the interest on pursuing an ICT career (Baloğlu and Çevik 2008; Downes and Looker 2011; Papastergiou 2008). The reported effects were mild and subject to high risk of bias. However, this evidence is neither strong enough to advice against the intensive use of computers in schools. We believe that intensive use of computers in schools, besides having some effects on attitudinal gender differences, might have other advantages, such as ensuring access to ICT technologies, especially for those children who have hardly any access to computers outside the school settings. Implementations issues cannot be neglected either and use of computers should be reinforced by appropriate teaching methodologies.

What methodologies do influence gender differences and to what extent? Interventions to reduce gender differences in the use of computers are complex in nature (Sáinz and López-Sáez 2010). It has been widely recognised that what happens during school years and particularly in schools, greatly determines the professional orientation of students (Papastergiou 2008) and ultimately the development of societies. Schools are a rich environment where all sorts of inputs are targeted towards students. Therefore, interventions promoting the use of computers never go alone and have to be embedded in this complexity, which may boost or minimise their potential effects.

Only two studies in our review did actually look at the influence of educational methods into the gender differentials in the use of ICT (Kaino 2008; Vekiri 2010) suggesting that student-centred learning and a social constructivist perspective in the collaborative work may help in reducing anxiety among girls.

The role of teachers may also influence the effects of interventions. For example, activities that girls perceive as useful favour the reduction of anxiety levels (Kaino 2008) and students in classrooms where teachers set up ICT activities which are really meaningful to them, show higher self-efficacy, consistently with other studies looking at teachers' roles (Volman and van Eck 2001). Teachers also act as role models (Papastergiou 2008; Vekiri 2010), which may influence gender differences in the use of ICT. Papastergiou (2008) also suggested strengthening the use of computers by increasing the number of female teachers specialised in ICT in schools, so as to become role models for the girls and revert the stereotyped perception of both genders.

What are the implications for policy and practice? In 2007 the European Union issued an educational policy to promote the use of computers among secondary students called 'eLearning Programme' (European Commission 2007). This policy explicitly suggested the potential effects of computers use in gender differentials on attitudes towards ICT and professional choices. However, we could not find any study specifically assessing the effects over reducing gender differences of this kind of intervention. This suggests that one-to-one strategies were implemented without a strong body of evidence supporting them.

Strikingly, none of the included studies addressed implementation issues such as procurement, time consumption or resources consumption, factors which may jeopardise the implementation of computer use interventions and which would have been very valuable to inform decision makers considering this type of interventions.

It is also important to note that, although it has been indicated that seven of the studies provide robust evidence to recommend implications for policy or practice, the fact is that observational studies are prone to bias and therefore can hardly provided robust enough evidence.

Our review had several limitations. First of all, studies were scrutinised for inclusion by a single reviewer due to resources constraints. However, to reduce the chances of excluding relevant studies, we maximised sensitivity in the application of the criteria and discussed doubtful studies with a senior research fellow reaching agreement by consensus.

We limited the search to the last 10 years. This was justified on the grounds of the level of implementation of computers in schools and on IT developments in recent years, which made computers widely available in school settings. We believe that previous evidence, if available, would be scanty and less relevant to the interventions currently being considered and to be developed in the future.

We cannot rule out publication bias, although we have made all efforts to widen the literature database searched and the sensitivity of the search strategies. However, it does not seem likely to us that robust experimental studies, which we did not find, could be found in other literature sources.

5 Conclusions

The intensive use of computers in schools is a global tendency in the educational sector and elsewhere. Its potential effects on computer literacy in general but also on reducing gender differences and empowering women to access ICT jobs on equal grounds as men cannot be overemphasised. Educational policies have the challenge to be responsive to these facts and need to be based on the best available evidence.

In relation to the first research question, our systematic review highlights the very limited and low quality evidence on the effects of intensive use of computers in schools on gender differences in attitudinal outcomes and reinforces the need to carry out more robust evaluations of existing and future interventions. It was striking the absence of comparative studies measuring these effects, which would allow more robust estimates of the effects of interventions and better-informed policies. Furthermore, evidence on implementation issues, context and resource consumption for families and governments was largely missing. These issues have been described as influencers of boys and girls attitudes (Cussó-Calabuig et al. 2017) and are equally important in formulating policies, which have to be rooted in specific budget constraints and socio-economic and cultural contexts.

This lack of evidence-informed decisions is consistent with the repeatedly confirmed lack of ICT professional women in many settings and the continued decline in the number of girls who choose ICT related studies, as shown by statistics from the OECD; not to mention, the consequences for the social and economical development of gender-equitable societies increasingly based on ICT.

As four our second research question, the relative lack of evidence on factors that may contribute to the reduction of gender differences was also striking. Specifically, we could not find data on the influence of the methodologies used by teachers to accompany the use of computers. This evidence is paramount to establish which are the most appropriate pedagogical and organisational arrangements to favour the reduction of gender gaps and increase girls' engagement on ICT.

Robust research on interventions to reduce gender differences related to ICT has to be actively promoted and adequately funded. Decision makers, responsive to societal needs, are required to demand good quality evidence to guide the implementation of ICT policies in the educational community and to evaluate the effects of this

implementation on the improvement of students' assessments, digital literacy and gender equality measures on attitudes and professional choices.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Appendix 1

Table 5 Search results

Database	Search terms	Keywords	Search result	Duplicated	First review	Second review
TESEO (TESEOnnn)	ordenador género		5			
ACM Digital Library (ACMnnn)	(computer or ICT) and gender and (attitude or self-efficacy or anxiety) and education and (secondary or high school)	women student education computer	78		3	
DART-Europe (DARTnnn)	(computer or ICT) and gender and (attitude or self-efficacy or anxiety) and education and (secondary or high school)		3			
ERIC (ERICnnn)	(computer or ICT) and gender and (attitude or self-efficacy or anxiety) and education and (secondary or high school)		380		21	5
Taylor and Francis (TAYnnn)	computer Keyword: education		10		3	
SAGE (SAGEnnn)	(computer use or ICT) and (attitude or self-efficacy) and (secondary or high school) and gender		17		1	1
Science Direct (SDnnn)	(computer or ICT) and gender and (attitude or self-efficacy or anxiety) and education and (secondary or high school)	women student education computer	247		31	3
TOTAL			740	40	59	9

Appendix 2: Studies not included after first review

Table 6 Studies not included and causes of exclusion

Authors	Country	Cause of no inclusion
Abbiss, J. (2011). Boys and machines: gendered computer identities, regulation and resistance. *Gender and Education*, *23*(5), 601–617.	New Zealand	No quantitative
Abbiss, J. (2008). Rethinking the "problem" of gender and IT schooling: discourses in literature. *Gender and Education*, *20*(2), 153–165.	New Zealand	No quantitative
Anderson, N., Lankshear, C., Timms, C., & Courtney, L. (2008). 'Because it's boring, irrelevant and I don t like computers': Why high school girls avoid professionally-oriented ICT subjects. *Computers and Education*, *50*(4), 1304–1318.	Australia	Only girls
Arigbabu, A. A. (2009). Examining psychometric characteristics of the computer anxiety scale. *Computers in Human Behavior*, *25*(1), 229–232.	Nigeria	Teachers
Asil, M., Teo, T. & Noyes, J. (2014). Validation and measurement invariance of the computer attitude measure for young students (CAMYS). *Journal of Educational Computing Research*, *51*(1), 49–69.	Singapore	Primary
Ballantine, J. A., McCourt Larres, P., & Oyelere, P. (2007). Computer usage and the validity of self-assessed computer competence among first-year business students. *Computers and Education*, *49*(4), 976–990.	New Zealand	University
Barron, B., Walter, S. E., Martin, C. K., & Schatz, C. (2010). Predictors of creative computing participation and profiles of experience in two Silicon Valley middle schools. *Computers and Education*, *54*(1), 178–189.	USA	No gender
Beyer, S. (2014). Why are women underrepresented in Computer Science? Gender differences in stereotypes, self-efficacy, values, and interests and predictors of future CS course-taking and grades. *Computer Science Education*, *24*(2–3), 153–192.	USA	University
Cázares, A. (2010). Proficiency and attitudes toward information technologies use in psychology undergraduates. *Computers in Human Behavior*, *26*(5), 1004–1008.	Mexico	University
Ertl, B., & Helling, K. (2011). Promoting gender equality in digital literacy. *Journal of Educational Computing Research*, *45*(4), 477–503.	Germany	No quantitative
Galpin, V. C., & Sanders, I. D. (2007). Perceptions of computer science at a South African university. *Computers and Education*, *49*(4), 1330–1356.	South Africa	University
Gansmo, H. J. (2009). Fun for all = digital competence for all? *Learning, Media, & Technology*, *34*(4), 351–355.	Norway	No quantitative

Table 6 (continued)

Authors	Country	Cause of no inclusion
Garland, K. J., & Noyes, J. M. (2008). Computer attitude scales: How relevant today? *Computers in Human Behavior*, *24*(2), 563–575.	UK	Scale validation
Gaudreau, P., Miranda, D., & Gareau, A. (2014). Canadian university students in wireless classrooms: What do they do on their laptops and does it really matter? *Computers and Education*, *70*, 245–255.	Canada	University
Gibson, P. A., Stringer, K., Cotten, S. R., Simoni, Z., O Neal, L. J., & Howell-Moroney, M. (2014). Changing teachers, changing students? the impact of a teacher-focused intervention on students computer usage, attitudes, and anxiety. *Computers and Education*, *71*, 165–174.	USA	No gender
Gokhale, A. A., Brauchle, P. E., & Machina, K. F. (2013). Scale to measure attitudes toward information technology. *International Journal of Information and Communication Technology Education*, *9*(3), 13–26.	USA	Scale validation
Hou, W., Kaur, M., Komlodi, A., Lutters, W. G., Boot, L., Cotten, S. R., ... & Tufekci, Z. (2006). Girls don't waste time. *CHI '06 extended abstracts on Human factors in computing systems - CHI EA '06* (p. 875).	Canada	No quantitative
Imhof, M., Vollmeyer, R., & Beierlein, C. (2007). Computer use and the gender gap: The issue of access, use, motivation, and performance. *Computers in Human Behavior*, *23*(6), 2823–2837.	Germany	Adults
Jara, I., Claro, M., Hinostroza, J. E., San Martín, E., Rodríguez, P., Cabello, T., Ibieta, A., & Labbé, C. (2015). Understanding factors related to chilean students Digital Skills: A Mixed Methods Analysis. *Computers and Education*, *88*, 387–398.	Chile	No gender
Koch, S. C., Müller, S. M., & Sieverding, M. (2008). Women and computers. Effects of stereotype threat on attribution of failure. *Computers and Education*, *51*(4), 1795–1803.	Germany	No intensive use of computers
Korobili, S., Togia, A., & Malliari, A. (2010). Computer anxiety and attitudes among undergraduate students in Greece. *Computers in Human Behavior*, *26*(3), 399–405.	Greece	University
Maricutoiu, L. P. (2014). A meta-analysis on the antecedents and consequences of computer anxiety. *Procedia - Social and Behavioral Sciences*, *127*, 311–315.	Romania	No gender
McLachlan, C., Craig, A., & Coldwell, J. (2010). Student perceptions of ICT: A gendered analysis. *Conferences in Research and Practice in Information Technology Series*, *103*, 127–136.	Australia	Older than 18
Meelissen, M. R. M., & Drent, M. (2008). Gender differences in computer attitudes: Does the school	Netherlands	Primary

Table 6 (continued)

Authors	Country	Cause of no inclusion
matter? *Computers in Human Behavior*, *24*(3), 969–985.		
Morris, S. A., Gullekson, N. L., Morse, B. J., & Popovich, P. M. (2009). Updating the attitudes toward computer usage scale using American undergraduate students. *Computers in Human Behavior*, *25*(2), 535–543.	USA	University
Papastergiou, M. (2010). Enhancing physical education and sport science students self-efficacy and attitudes regarding information and communication technologies through a computer literacy course. *Computers and Education*, *54*(1), 298–308.	Greece	University
Pau, R., Hall, W., & Grace, M. (2011). 'It 's boring': female students' experience of studying ICT and computing. *School Science Review, 92*(341), 89–94.	UK	University
Popovich, P. M., Gullekson, N., Morris, S., & Morse, B. (2008). Comparing attitudes towards computer usage by undergraduates from 1986 to 2005. *Computers in Human Behavior*, *24*(3), 986–992.	USA	University
Powell, A. L. (2013). Computer anxiety: Comparison of research from the 1990s and 2000s. *Computers in Human Behavior*.	USA	Scale validation
Poynton, T. A. (2005). Computer literacy across the lifespan: a review with implications for educators. *Computers in Human Behavior*.	USA	No quantitative
Purvanova, R. K., & Muros, J. P. (2010). Gender differences in burnout: a meta-analysis. *Journal of Vocational Behavior*, *77*(2), 168–185.	USA	Older than 18
Rosson, M. B., Carroll, J. M., & Sinha, H. (2011). Orientation of undergraduates toward careers in the computer and information sciences. *ACM Transactions on Computing Education*, *11*(3), 1–23.	USA	University
Sáinz, M., & López-Sánchez, M. (2010). Gender differences in computer attitudes and the choice of technology-related occupations in a sample of secondary students in Spain. *Computers and Education*, *54*(2), 578–587.	Spain	Not expected outcomes
Sáinz, M., & Eccles, J. (2012). Self-concept of computer and math ability: gender implications across time and within ICT studies. *Journal of Vocational Behavior*, *80*(2), 486–499.	Spain	No intensive use of computers
Schroeders, U., & Wilhelm, O. (2011). Computer usage questionnaire: structure, correlates, and gender differences. *Computers in Human Behavior*, *27*(2), 899–904.	Germany	Not expected outcomes
Shank, D. B., & Cotten, S. R. (2014). Does technology empower urban youth? The relationship of technology use to self-efficacy. *Computers and Education*, *70*, 184–193.	USA	Older than 18

Table 6 (continued)

Authors	Country	Cause of no inclusion
Sieverding, M., & Koch, S. C. (2009). (Self-)Evaluation of computer competence: How gender matters. *Computers and Education*, *52*(3), 696–701.	Germany	University
Simsek, A. (2011). The relationship between computer anxiety and computer self-efficacy. *Contemporary Educational Technology*, *2*(3), 177–187.	Turkey	Teachers
Spanos, D., & Sofos, A. (2015). The views and attitudes of students participating in a one-to-one laptop initiative in Greece. *Education and Information Technologies*, *20*(3), 519–535.	Greece	One school
Tang, T. L. P., & Austin, M. J. (2009). Students perceptions of teaching technologies, application of technologies, and academic performance. *Computers and Education*, *53*(4), 1241–1255.	USA	University
Teo, T. (2006). Attitudes toward computers: A study of post-secondary students in Singapore. *Interactive Learning Environments*, *14*(1), 17–24.	Singapore	One school
Teo, T., & Noyes, J. (2008). Development and validation of a computer attitude measure for young students (CAMYS). *Computers in Human Behavior*, *24*(6), 2659–2667	Singapore	Scale validation
Tømte, C., & Hatlevik, O. E. (2011). Gender-differences in self-efficacy ICT related to various ICT-user profiles in Finland and Norway. How do self-efficacy, gender and ICT-user profiles relate to findings from PISA 2006. *Computers and Education*, *57*(1), 1416–1424.	Norway	No quantitative
Tuncer, M., Doğan, Y., & Tanaş, R. (2013). Investigation of vocational high-school students computer anxiety. *Turkish Online Journal of Educational Technology*, *12*(4), 90–95.	Turkey	One school
Varank, I. (2007). Effectiveness of quantitative skills, qualitative skills, and gender in determining computer skills and attitudes: a causal analysis. *The Clearing House*, *81*(2), 71–80.	Turkey	University
Varma, R. (2009). Gender differences in factors influencing students towards computing. *Computer Science Education*, *19*(1), 37–49.	USA	University
Vekiri, I., & Chronaki, A. (2008). Gender issues in technology use: perceived social support, computer self-efficacy and value beliefs, and computer use beyond school. *Computers and Education*, *51*(3), 1392–1404	Greece	Primary
Verhoeven, J. C., Heerwegh, D., & De Wit, K. (2010). Information and communication technologies in the life of university freshmen: An analysis of change. *Computers and Education*, *55*(1), 53–66.	Belgium	University
Von Hellens L., Clayton K., Beekhuyzen J., & Nielsen, S. (2009). Perceptions of ICT careers in german	Germany	Not expected outcomes

Table 6 (continued)

Authors	Country	Cause of no inclusion
schools: an exploratory study. *Journal of Information Technology Education*, *8*, 211–228.		
Wade, M. (2010). *Laptops and the gender gap: An investigation of a high school core curriculum program. Dissertation Abstracts International*. ProQuest Information & Learning; US.	USA	One school

Appendix 3

Table 7 Studies included in the review

Authors	Title
Baloğlu M. and Çevik. V (2008)	Multivariate effects of gender, ownership, and the frequency of use on computer anxiety among high school students,
Christoph G., Goldhammer F., Zylka J. and Hartig J. (2015)	Adolescents' computer performance: The role of self-concept and motivational aspects
Downes T. and Looker D. (2011)	Factors that Influence Students' Plans to Take Computing and Information Technology Subjects in Senior Secondary School
Fančovičová J. and Prokop P. (2008)	Students' Attitudes toward Computer Use in Slovakia
Kaino L.M. (2008)	Technology in Learning: Narrowing the Gender Gap?
Kubiatko et al. (2011)	Slovak high school students' attitudes toward computers
Papastergiou M. (2008)	Are Computer Science and Information Technology Still Masculine Fields? High School Students' Perceptions and Career Choices
Teo T. (2008)	Assessing the computer attitudes of students: An Asian perspective
Vekiri I. (2010)	Boys' and Girls' ICT Beliefs: Do Teachers Matter?

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Adebowale, O., Adediwura, A., Bada, T. (2009). Correlates of computer attitude among secondary school students in Lagos State, Nigeria. *International Journal of Computing and ICT Research, 3*(2), 20–30.

Baloğlu, M., & Çevik, V. (2008). Multivariate effects of gender, ownership, and the frequency of use on computer anxiety among high school students. *Computers in Human Behavior, 24*(6), 2639–2648. https://doi.org/10.1016/j.chb.2008.03.003.

Bebell, D., & Kay, R. (2010). One to one computing: A summary of the quantitative results from the Berkshire wireless learning initiative. *Journal of Technology, Learning, and Assessment, 9*(2).

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