IEA Research for Education

A Series of In-depth Analyses Based on Data of the International Association for the Evaluation of Educational Achievement (IEA)

Eveline Gebhardt
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Gender Differences in Computer and Information Literacy

An In-depth Analysis of Data from ICILS

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Volume 8

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Preface

IEA's mission is to enhance knowledge about education systems worldwide, and to provide high-quality data that will support education reform and lead to better teaching and learning in schools. In pursuit of this aim, it conducts, and reports on, major studies of student achievement in literacy, mathematics, science, citizenship, and digital literacy. These studies, most notably TIMSS, PIRLS, ICCS, and ICILS, are well established and have set the benchmark for international comparative studies in education.

The studies have generated vast datasets encompassing student achievement, disaggregated in a variety of ways, along with a wealth of contextual information which contains considerable explanatory power. The numerous reports that have emerged from them are a valuable contribution to the corpus of educational research.

Valuable though these detailed reports are, IEA's goal of supporting education reform needs something more: deep understanding of education systems and the many factors that bear on student learning advances through in-depth analysis of the global datasets. IEA has long championed such analysis and facilitates scholars and policymakers in conducting secondary analysis of our datasets. So, we provide software such as the International Database Analyzer to encourage the analysis of our datasets, support numerous publications including a peer-reviewed journal—*Large-scale Assessment in Education*—dedicated to the science of large-scale assessment and publishing articles that draw on large-scale assessment databases, and organize a biennial international research conference to nurture exchanges between researchers working with IEA data.

The **IEA Research for Education** series represents a further effort by IEA to capitalize on our unique datasets, so as to provide powerful information for policymakers and researchers. Each report focuses on a specific topic and is produced by a dedicated team of leading scholars on the theme in question. Teams are selected on the basis of an open call for tenders; there are two such calls a year. Tenders are subject to a thorough review process, as are the reports produced. (Full details are available on the IEA website.)

This eighth volume in the series deals with an issue that is especially timely in an information era—that of gender differences in computer literacy. Given the importance of technology in our day-to-day lives and the dominant role that computers and digital devices play, examining the existence of a gender-based digital divide is crucial by any measure. This is especially important, as the impact of digital gaps can be severe. For example, in the United States alone, high school aged boys are far more likely than girls to enroll in advanced computer science courses (81% to 19%, respectively) and this disparity carries over into higher education, where just 18% of computer science degrees are awarded to women (National Girls Collaborative Project 2019). In the light of these differences, necessarily, women will be underrepresented in the technology labor force, a sector with many highly skilled and well-paid jobs in industrialized countries. Viewed purely from an economic perspective, such a divide neglects an enormous store of human capital, reducing capacity and risking lower economic growth. Clearly, a first step in any discussion around a digital divide is to understand the degree to which a population is technology literate and what differences in computer literacy exist between males and females. In this volume, the authors do just that.

To gain a better understanding about computer and information literacy, the authors use data from the 2013 cycle of the IEA's International Computer and Information Literacy Study (ICILS). ICILS is a survey of grade eight students, designed to answer the question "How well are students prepared for study, work, and life in the digital age?" Here, computer and information literacy (CIL) is defined as "students' ability to use computers to investigate, create, and communicate in order to participate effectively at home, at school, in the workplace, and in the community." Using a variety of methods and perspectives, the authors examine not only gender differences among students but also among their teachers. Including this latter aspect is particularly relevant, given empirical evidence regarding teachers' influence on student outcomes (Darling-Hammond 2000).

The sorts of issues taken up in this volume include (1) gender differences in computer literacy, (2) gender differences in attitudes toward computer use, and (3) how male and female teachers differ in their use of technology in teaching. This list is not exhaustive, but it offers some examples of what readers will find. As with much cross-cultural research, this volume shows that the answer to many of the queries is "it depends"; cross-country differences are ubiquitous. As just one example, the correlation between information and communication technology use during lessons and CIL is positive in Australia but negative in Lithuania, and these relationships are consistent between boys and girls. This high-level view of the data does not and cannot offer definitive explanations for these differences; however, these findings open the door for further in-depth research. The ICILS database is rich and interesting and offers a treasure trove of material for research. Besides adding to the literature on the digital divide, we find this volume to be an example of the ways in which ICILS can be used to answer pressing and timely questions around technology literacy in the modern era. As a final note, ICILS was administered for a second time in 2018, and the results are to be released in November 2019. This second cycle offers further possibilities for analyzing trends over time to evaluate the stability of the 2013 findings.

Seamus Hegarty
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Series editors

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Contents

Chapter 1
Introduction to Gender Differences in Computer and Information Literacy

Abstract As computer and information technologies increasingly dominate modern life, educators and policymakers recognize the importance of ensuring that all students are able to use computers to investigate, create, and communicate effectively. Intriguingly, results from IEA's International Computer and Information Literacy Study (ICILS) of grade eight students, undertaken in 2013, indicated that female students generally had higher computer and information literacy (CIL) scale scores than male students. This book further analyzes the data collected by ICILS 2013, providing an in-depth investigation of the gender differences in the CIL abilities of students and their teachers. After establishing how CIL (and other similar constructs) are assessed, this chapter reviews the existing research into gender differences in students' CIL; this is based mainly on data collected by large-scale assessments. Patterns in students' use of information and computer technologies, their perceptions of computer technology, and their sense of competence in using computer technologies reveal gender differences that might be associated with the differing development of students' CIL. Gender differences among teachers, in their confidence in the use of computer technologies and their attitudes to the pedagogical use of those technologies, are also examined.

Keywords Computer and information literacy (CIL) · Gender differences · Information and communications technologies (ICT) · International Computer and Information Literacy Study (ICILS) · International large-scale assessments

1.1 Introduction

Information and communications technologies (ICT) have significantly changed how people interact with each other, and the ways people live and work around the world. The evolution of ICT has also affected teaching and learning in schools, and education systems have recognized the importance of developing their students' capacity to use these technologies for a range of purposes beyond basic ICT skills. IEA's International Computer and Information Literacy Study (ICILS) was designed to establish how well students around the world were prepared for study, work, and life in the digital age. ICILS 2013 referred to these capacities as computer

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and information literacy (CIL). CIL was defined as “an individual’s ability to use computers to investigate, create, and communicate in order to participate effectively at home, at school, in the workplace, and in society” (Fraillon et al. 2014, p. 17). The ICILS 2013 CIL construct comprised two strands: (1) using computer technologies to collect and manage information, and (2) using computer technologies to produce and exchange information.

Educators and systems have also recognized the importance of ensuring that both male and female students develop those capacities. Many large-scale educational assessments in a range of countries have reported that, on average, female students score higher than male students on ICT-related assessments, such as national studies in Australia (ACARA [Australian Curriculum, Assessment and Reporting Authority] 2015), Chile (Claro et al. 2012), and the Republic of Korea (Kim and Lee 2013; Kim et al. 2014). These results are intriguing because they defy commonly held expectations and do not reflect the gender balance in employment patterns in computer-related industries or participation in further studies in computing and information technology.

In this report, we aim to provide a systematic investigation of gender differences in computer literacy, computer usage, and attitudes to computer technology, based on the data collected by ICILS 2013 (Fraillon et al. 2014). In the early days of computing in schools it was evident that computer use was dominated by male teachers (for example, see Reinen and Plomp 1993). However, the use of ICT has become more prevalent since the days of the Computers in Education study (COMPED; see IEA 2019a), and so to gauge changes, we investigate the use of computer technologies in the classroom by female and male teachers. Teachers’ personal use of, and attitudes to, computer technologies in the lower secondary school years may also have an effect on their students, either directly, through their instructional practices or frequency of use of ICT in the classroom, or indirectly, through modeling of behavior. The associated teacher questionnaires delivered as part of ICILS 2013 thus provide a rich data resource that may better explain student achievement (Fraillon et al. 2014). While previous research has certainly investigated gender differences in student and teacher capabilities and their use of digital technologies, the literature for students is more extensive than that for teachers (Heemskerk et al. 2005; Volman and van Eck 2001).

In this chapter, we review the relevant research literature on gender differences in CIL among students, beginning with a summary of findings for measured CIL (and similar constructs) drawn mainly from large-scale assessments. We then consider studies reporting gender differences in factors that might be associated with the development of students’ CIL: namely patterns in students’ use of ICT, and their perceptions of computer technology and sense of competence in using computer technologies. We also consider gender differences in teachers’ confidence in using computer technologies and teachers’ attitudes to the pedagogical use of those technologies. After reviewing the existing literature, we formalize a set of research questions to guide our investigation.

1.2 Students and Computer Technologies

Knezec and Christensen (2018) noted that, while competencies in computer technologies, computer use, and computer-related attitudes were once considered separate but related aspects of the field, they have come to be seen as integrated. It is thus important that we not only review literature concerned with gender differences in these aspects of student computer literacy but also review information about gender differences in CIL and related constructs, patterns of computer use, and perceptions of computer technology (including consideration of student attitudes to computer technologies and their perceptions of their capacities to use those technologies).

1.2.1 Students' Computer and Information Literacy

Large-scale assessments of students' CIL have reported that, on average, female students perform better than male students on computer, digital, or ICT literacy assessments (the terminology varies, but the constructs remain similar). Results from IEA's ICILS 2013, conducted in 21 countries,[1] indicated that female grade eight students achieved significantly higher CIL scores than male students (Fraillon et al. 2014). The difference between the international average scores for female and male students was equivalent to about one-fifth of the ICILS standard deviation. As part of the Organisation for Economic Cooperation and Development's (OECD) Programme for International Student Assessment (PISA) in 2009, 19 countries participated in an option that focused on assessing the digital reading capabilities of 15-year-old students (OECD 2011). Female students scored higher than male students on that assessment of digital reading, with the average difference being one-quarter of a standard deviation.

Similar results have been reported across a range of national assessments of computer literacy. In the 2014 National Assessment of Educational Progress in the United States, female grade eight students scored higher than male grade eight students in the ICT content area of the assessment of technological and engineering literacy by approximately one-sixth of a standard deviation (NCES [National Center for Educational Statistics] 2016a, b). In Australia, over four cycles of national assessment of ICT literacy at grades six and 10, the difference between the performance of female and male students averaged one-fifth of a standard deviation (ACARA 2015). Similar size differences (that is, about one-fifth of a standard deviation) were reported between female and male students at elementary and middle levels of school in the Republic of Korea's national assessment of ICT literacy (Kim

[1]In this report, educational systems are sometimes referred to as "countries." This is for ease of reading, but it should be noted that there are a number of systems that are not countries as such, but are provinces or regions within a country with a degree of educational autonomy that have participated following the same standards for sampling and testing.

and Lee 2013; Kim et al. 2014). Aesaert and van Braak (2015) reported similar differences for upper primary school students in the Netherlands, while Hatlevik et al. (2015) reported statistically significant, but slightly smaller differences in favor of female students in a study of a sample of upper primary students in Norway.

There have been some large-scale studies that reported no gender differences in computer literacy. ICILS 2013 identified only two countries, Thailand and Turkey, where there were no significant gender differences in achievement (Fraillon et al. 2014). Among the 19 countries that took part in the OECD PISA 2009 study of digital reading, only Colombia reported no gender differences in student achievement (OECD 2011). In a large-scale assessment of the ICT literacy of Chilean 15-year-olds, there were no significant differences found between female and male students (Claro et al. 2012). Hatlevik and Christophersen (2013) also reported no significant gender differences in digital literacy among senior secondary students in Norway.

Some have argued that gender differences vary across different types of computer task. Punter et al. (2017) used data from ICILS 2013 to identify three subscales of CIL: technical functionality, evaluating and reflecting on information, and sharing or communicating information (such as through an information product). They found that female students performed better than male students on both evaluating and reflecting on information (nine countries) and sharing and communicating information (nine countries), with these two subscales being highly correlated. On the subscale of technical functionality, however, the differences between female and male students were not significant in four countries, in favor of male students in five countries, and in favor of female students in five countries. A study of upper grade students in Finnish comprehensive schools reported a very small, but statistically significant, difference in favor of female students on overall ICT literacy, with male students performing better on technical-oriented items and female students performing better on "school work-oriented and social interaction" items (Kaarakainen et al. 2018). The argument put forward by Punter et al. (2017) provides a plausible explanation of why the relative computer literacy achievements of female and male students might have changed over time, as there has been a change in computer use from the more technical to a focus on applications incorporating information management and communications that make use of the internet. Changes in the balance of assessment items focusing on different domains or subskills of CIL could contribute to explanations of why some assessments generate different results to the majority (differences in the balance of items across assessments). Accordingly, the current report examines not only the overall CIL scale scores of male and female students, but also item-level performance data.

1.2.2 Gender Differences in Student Technology Use

When computer technologies were being introduced into schools, the use of ICT was more extensive among male than female students (Lockheed 1985). However, as the use of computer technologies became more prevalent, the overall differences in computer use between male and female students appeared to decrease (Colley and Comber 2003). Potential gender differences in computer usage have remained of interest because computer use at home has been identified as a predictor of measured CIL, although the association may not be linear (Bundsgaard and Gerick 2017; Fraillon et al. 2014). More recently, the differences between female and male students in terms of the percentages who report using computer technologies on a daily basis appear to have been negligible. Analyses of ICILS 2013 data showed that 57% of male students and 52% of female students used computers at home at least once each day (Fraillon et al. 2014). While this overall difference may be viewed as negligible, the magnitude of the difference between the proportions of male and female students who reported daily use of computers varied across countries (Fraillon et al. 2014). In the Australian national assessment of ICT literacy, there were no significant differences between the percentages of female and male students who reported daily computer use at home or school, either in primary or secondary school (ACARA 2015).

However, there are some differences between male and female students in the types of computer use. According to ICILS 2013, female students made slightly greater use of computer technologies for schoolwork or study purposes than male students, while male students used ICT more frequently for exchanging information and for recreational purposes (Fraillon et al. 2014). Similar findings were reported in PISA 2009 (OECD 2011).

1.2.3 Gender Differences in Student Perceptions of Computer Technology

Punter et al. (2017) noted that many studies have attributed the lower use of computer technologies among female students and lower levels of female participation in computer-based industries to differences in attitudes. Research in this area focused mainly on gender differences in computer-related attitudes, such as liking computers, perceived usefulness of computers, self-confidence in computer use, and anxiety in using computers (Meelissen 2008). These differences identified in the early literature appear to have remained largely unchanged in recent years. In ICILS 2013, male students expressed greater interest and enjoyment in using computer technology than did female students, although this finding varied across countries (Fraillon et al. 2014). Similarly, PISA 2009 reported that male students showed more positive attitudes than female students towards computers (OECD 2011).

The Australian national assessment of ICT literacy indicated that students in late primary and mid-secondary school expressed high levels of interest and enjoyment in working with computers (ACARA 2015). However, interest and enjoyment were higher among male than female students at both stages of schooling, and interest was higher among primary students than secondary school students. Positive associations between ICT literacy and interest and enjoyment in working with computers were identified in both late primary and mid-secondary stages of school, with the associations being stronger among male students than female students (ACARA 2015).

In general, research has indicated that gender differences in students' attitudes towards computer technologies run counter to the gender differences in achievement in CIL. We thus aimed to explore gender differences in interest in and enjoyment of computer and information technologies, patterns of particular use (i.e., for social communication, for exchange of information, for recreation, and for study purposes), and potential associations between these differences and CIL.

1.2.4 Students' ICT Self-efficacy

Many studies of computer, digital, or ICT literacy have made use of self-reports, where students are asked to evaluate how well they believe they can perform on ICT-related tasks. The construct measured by these self-reports is called ICT self-efficacy. Studies of self-efficacy from the early stages of the introduction of computer technology to schools have consistently found that male students rate their competence more highly than their female peers (Cooper 2006; Volman and van Eck 2001). Rohatgi et al. (2016) analyzed the Norwegian ICILS 2013 data, and noted that ICT self-efficacy may not be a unidimensional construct. They distinguished general ICT self-efficacy from specialized ICT self-efficacy (sometimes referred to as self-efficacy with basic and advanced skills) and determined that general ICT self-efficacy was positively related to computer literacy, whereas specialized ICT self-efficacy was negatively, but minimally associated with computer literacy. ICILS 2013 found that female students, on average, reported slightly higher levels of ICT self-efficacy than male students in relation to basic ICT tasks (about one-tenth of a standard deviation), whereas male students reported much higher levels of ICT self-efficacy in relation to advanced ICT tasks (by about half a standard deviation) (Fraillon et al. 2014). Similar results have been reported for grade six and grade 10 students in Australia (ACARA 2015). This variability in self-confidence in performing tasks with different levels of difficulty has become more apparent over time, likely in line with increasing use of ICT both inside and outside the classroom. For basic ICT self-efficacy tasks there is now a very strongly skewed distribution of responses; most students report that they can perform simple basic tasks. Thus, what is now being observed in the factor structure may be a distinction between tasks that almost all students think they can perform, and tasks that only some students think they can perform. For example, while 87% of students participating in ICILS 2013 agreed that they could search for and find a file on a computer and 89% agreed that they could search for and find information on the internet, only 30% agreed that they could create a database and only 38% agreed that they could build or edit a webpage (Fraillon et al. 2014).

Siddiq et al. (2016) cautioned that measures of self-confidence or self-efficacy do not provide sound measures of ICT literacy because they correlate poorly with measured competence. It is thus important to distinguish between computer literacy and self-confidence in using those technologies, and most studies have concluded that the two constructs are distinct. The Australian National Assessment Program for ICT literacy also found that measures of ICT self-efficacy were not equivalent for male and female students: male students were more confident than female students about using ICT, but this confidence was not reflected in measured computer literacy (ACARA 2015). In PISA 2009, 15-year-old male students reported greater levels of self-confidence in completing high-level ICT tasks than female students, but female students recorded higher average scores on digital reading, which is a form of computer literacy (OECD 2011).

1.3 Teachers and Computer Technologies

1.3.1 Gender Differences in Teacher Confidence in Using ICT

One of the enduring research issues involved in the study of the differential use of computer technologies in teaching concerns teacher confidence or ICT self-efficacy. Indeed, among the many purposes of professional learning in computer technologies is to enhance teacher expertise and confidence in computer technologies and their pedagogical applications. The Second Information Technology in Education Study 2006 (SITES 2006; see IEA 2019b) surveyed the role of ICT in science and mathematics in grade eight teaching in 22 countries and reported that the use of ICT was greater when teachers had a higher level of confidence in using ICT, when teachers had participated in ICT-related professional development, and when there were fewer contextual obstacles (infrastructure, digital learning resources, ICT access) (Law et al. 2008). The European Commission (2013) also reported that teachers who were confident users of ICT were more likely to adopt ICT as part of their teaching. However, the results from SITES 2006 also suggested that the relationship between ICT self-efficacy and the use of digital technologies was not determinist, and that there were variations in the relationship across countries and among environments within countries. Among the possible reasons for the apparent differences in results concerning the relationship between gender and computer self-efficacy could be that the self-efficacy construct is multifaceted and the strength of (or even the direction of) the relationship depends on the facet that is being addressed by the instrument.

Scherer and Siddiq (2015) analyzed ICILS 2013 teacher data from Norway and identified three aspects of teacher ICT self-efficacy: in basic operational skills, a combination of advanced operational and collaborative skills, and in using computers for instructional purposes. This was a similar structure to that reported from SITES 2006. Scherer and Siddiq (2015) found that the structure was the same for male and female teachers, although there were differences found on some aspects. Male teachers had higher self-efficacy with respect to both basic and advanced operational skills, but there were no significant gender differences in confidence in using computers for instructional purposes. Markauskaite (2006) reported differences in the self-reported technical ICT capabilities of male and female preservice teachers. In contrast, Sang et al. (2010) reported that gender was unrelated to teacher ICT self-efficacy, their attitudes to computing, or teacher prospective computer use after mediating variables were taken into account.

Most studies that have reported on teachers' ICT competencies have relied on self-report data. However, one of the few performance assessments of ICT skills among teachers identified three ICT skill factors: basic digital skills, advanced technical skills, and professional ICT skills (Kaarakainen et al. 2018). Interestingly, these dimensions appear to be similar to those reported from studies of ICT self-efficacy. Results from this assessment indicated that male teachers outperformed female teachers in the assessment of ICT skills that they used; these results mirror the patterns found among assessments of students.

1.3.2 Teacher Perceptions About and Use of Digital Technologies

There are conflicting claims about the influence of gender on the pedagogical use of ICT (Teo 2008). Some argue that male teachers tend to be more interested in learning about and using digital technologies (Schumacher and Morahan-Martin 2001; Yuen and Ma 2002). However, more recent studies suggest that the differences are neither large nor consistent across varied contexts.

SITES 2006 stressed the importance of the reciprocal relationships between teachers' pedagogical orientations and their use of ICT in teaching (Law et al. 2008). Ertmer et al. (2012) reported on the importance of teachers' general beliefs about teaching, and on their interest in technology itself, for the extent and manner of technology use in classrooms. ICILS 2013 included a set of questions asking teachers about the benefits of ICT in school education. Data based on responses to these questions were used to identify two orthogonal dimensions: positive views and negative views (Fraillon et al. 2014). The implication was that it was possible to hold both sets of views simultaneously. The level of use of computer technologies in teaching was higher among those teachers who had positive views of the roles of these technologies in school education and lower among those who held negative views about ICT (Fraillon et al. 2014). Gender differences on these scales were not reported.

Studies of teacher use of computer technologies have drawn attention to the importance of the environment in which teaching takes place. One aspect of the teaching environment is the learning or subject area in which teaching takes place. SITES 2006 found that the pedagogical use of ICT was greater in science classrooms than in mathematics classrooms (Law et al. 2008). ICILS 2013 also reported that the pedagogical use of ICT varied across learning areas. Aside from teaching in computer studies classes, the pedagogical use of ICT was considerably greater in the sciences and the humanities than in mathematics and the creative arts (Fraillon et al. 2014). As the distribution of male and female teachers across learning areas is not uniform, these findings suggest that comparisons of the pedagogical use of computer technologies by female and male teachers need to take into account the subject areas in which they are teaching.

1.4 Research Questions

We derived a set of research questions designed to systematically investigate the gender differences in computer literacy, computer usage, and attitudes to computer technology in the ICILS 2013 data. These research questions can be divided into two groups. The first set of questions focus on students.

RQ1 *What is the magnitude of the difference between female and male students in measured computer literacy overall, and for particular types of items?*
RQ2 *To what extent do female and male students differ in computer self-efficacy overall, and in particular aspects of computing?*
RQ3 *To what extent do female and male students differ in their patterns of computer use and in their attitudes to computer technology?*

The second set of research questions concerned teachers.

RQ4 *To what extent do female and male teachers differ in computer self-efficacy overall and in relation to particular aspects of computing?*
RQ5 *To what extent do female and male teachers differ in their attitudes towards the use of computer technologies in school education?*
RQ6 *To what extent do female and male teachers differ in the ways in which they use computer technologies in their teaching?*

1.5 Structure of This Report

The chapters that follow this introduction address our six research questions in Sect. 1.4. Chapter 2 provides an overview of the ICILS study, describes the instruments and data, discusses the methods of analysis and variables used, and measures of significance and effect. Chapter 3 addresses research question RQ1 (measured computer literacy) and research question RQ2 (computer self-efficacy). It discusses each of these measures and the relationship between them for female and male students. Chapter 4 addresses research question RQ3 and examines differences between female and male students in their patterns of computer use and their attitudes towards computer technology. Research questions RQ4, RQ5, and RQ6, concerned with differences between female and male teachers of grade eight students in computer self-efficacy, attitudes to the pedagogical use of computer technology, and the uses made of computer technology in teaching, are the focus of Chap. 5. Chapter 6 provides an overview and interpretation of gender differences in computer literacy and computer use in schools.

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Chapter 2
Data and Methods Used for ICILS 2013

Abstract IEA's International Computer and Information Literacy Study (ICILS) was designed to establish how well students around the world were prepared for study, work, and life in the digital age. This chapter describes the ICILS 2013 study design, the sample design, scaling methods, and the variables used, and outlines the practical significance of particular results.

Keywords Computer and information literacy (CIL) · Gender differences · Information and communications technologies (ICT) · International Computer and Information Literacy Study (ICILS) · International large-scale assessments · Methodology

2.1 Sampling

This report is based on secondary analyses of student and teacher data from ICILS 2013 (Fraillon et al. 2015). ICILS 2013 gathered data from almost 60,000 grade eight (or equivalent) students and 35,000 teachers of grade eight students in more than 3300 schools from 21 countries. In each country, the samples were designed as two-stage cluster samples. During the first stage, schools were sampled with a probability proportional to the numbers of students enrolled in a school. Twenty students were then randomly sampled from all students enrolled in the target grade. In schools with fewer than 20 students, all students were invited to participate (Meinck 2015). These student data were augmented by data from almost 35,000 teachers in those schools. From the sampled schools, a minimum of 15 teachers was selected at random from all teachers teaching the target grade, but in schools with 20 or fewer such teachers, all teachers were invited to participate (Meinck 2015).

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2.1.1 Data Collection

The main ICILS survey took place in the 21 participating education systems (18 countries and three benchmarking education systems) between February and December 2013 (the survey took place between February and June 2013 in the Northern Hemisphere countries, and between October and December 2013 in the Southern Hemisphere countries).

Students completed a computer-based test of CIL that consisted of questions and tasks presented in four 30-min modules. Each student completed two modules randomly allocated from the set of four, so that the total assessment time for each student was one hour (Fraillon et al. 2015). The psychometric properties of the student assessment have been reported by Gebhardt and Schulz (2015). After completing the two test modules, students completed a 30-min questionnaire (again on computer) that included questions relating to students' background characteristics, their interest in and enjoyment of using ICT, their experience and use of computers and ICT to complete a range of different tasks in school and out of school, and use of ICT during lessons at school (Schulz and Ainley 2015).

Teachers completed a 30-min online questionnaire about their background and familiarity with ICT, their confidence in using ICT, and their use of ICT in teaching in general and with a randomly-selected reference class. In this questionnaire, teachers were asked about the emphasis they placed on developing students' CIL, their views about the use of ICT in teaching and their participation in professional learning relating to pedagogical use of ICT. The properties of the student and teacher-based scales have been reported by Schulz and Friedman (2015).

2.1.2 Participation and Response Rates

Despite the efforts of participating countries and educational systems to meet the minimum response rates required, not all countries who participated in ICILS 2013 had data that allowed for further investigation in the current report. Fourteen countries met the minimum participation requirements for comparing student achievement and 12 countries met the minimum response rate requirement for teacher responses (Table 2.1). Germany and Norway met the student response rate criteria but failed to meet the teacher response rate criteria. Three benchmarking participants (Ontario in Canada, Newfoundland and Labrador in Canada, and the city of Buenos Aires in Argentina) also participated in ICILS 2013, however, in this report we focus only on full country participants.

Table 2.1 ICILS 2013 weighted survey response rates

Country	Overall student participation rate (%)	Met criteria for student survey	Overall teacher response rate (%)	Met criteria for teacher survey
Australia	86.3	Yes	79.0	Yes
Chile	93.4	Yes	95.9	Yes
Croatia	81.1	Yes	96.0	Yes
Czech Republic	93.7	Yes	99.9	Yes
Denmark	64.1	No	49.7	No
Germany	75.2	Yes (with replacements)	64.9	No
Hong Kong SAR	68.6	No	58.3	No
Republic of Korea	96.3	Yes	99.9	Yes
Lithuania	88.8	Yes	85.6	Yes
Netherlands	71.9	No	49.5	No
Norway (grade nine)	83.4	Yes	64.5	No
Poland	86.3	Yes	93.6	Yes
Russian Federation	92.8	Yes	98.4	Yes
Slovak Republic	92.3	Yes	97.7	Yes
Slovenia	90.0	Yes	88.1	Yes
Switzerland	43.5	No	27.2	No
Thailand	88.8	Yes	85.4	Yes
Turkey	85.8	Yes	95.8	Yes

Only those countries that met the following response rate requirements, either initially or after replacements were recruited, were included in the analyses in this report:

- an unweighted school response rate without replacement of at least 85% (after rounding to the nearest whole percent) and an unweighted overall student/teacher response rate (after rounding) of at least 85%, or
- a weighted school response rate without replacement of at least 85% (after rounding to the nearest whole percent) and a weighted overall student/teacher response rate (after rounding) of at least 85%, or
- the product of the (unrounded) weighted school response rate without replacement and the (unrounded) weighted overall student/teacher response rate of at least 75% (after rounding to the nearest whole percent).

2.1.3 Weighting of Data

One of the main objectives of any large-scale international study is to obtain estimates of population characteristics. In order to draw accurate conclusions about the population, researchers need to take into account the complex sample design implemented in all countries, in particular, the critical characteristic that sampling units do not have equal probability of selection. In addition, nonparticipation of schools, teachers, and students, in particular differential patterns of nonresponse, have the potential to bias results. To account for these complexities, sampling weights and nonresponse adjustments were calculated for each country, leading to an estimation (or “final”) weight for each sampled unit. Further detailed information on the weighting procedures used in ICILS 2013 are available in the ICILS 2013 technical report (Fraillon et al. 2015). All findings presented in this report are based on appropriately weighted data.

2.2 Measures and Scales

In our analyses we used measures (based on responses to single items) and scales (constructed from responses to a number of similar items) that were derived for the ICILS 2013 international student assessment, and the student and teacher survey questionnaires. No new scales were created for the analyses reported in this volume. In this report, we considered four variables derived from the international student assessment.

2.2.1 Student Computer Literacy

The Rasch item response model (Rasch 1960) was used to derive the CIL scale from student responses to the 62 test questions and large tasks (which corresponded to a total of 81 score points). The final reporting scale was set to a metric that had a mean of 500 (the ICILS average score) and a standard deviation of 100 for equally-weighted national samples. Plausible value methodology with full conditioning was used to derive summary student achievement statistics. Student computer literacy is a dependent variable.

2.2.2 Student Performance Measures on CIL Strand Items

Similarly to the full measure of CIL, students’ performance on seven strands of CIL items (creating information, transforming information, sharing information, accessing and evaluating information, managing information, knowing about and understanding computer use, and using information safely and securely) was scaled to a mean of 500 with a standard deviation of 100. Student performances on different strand items were considered to be dependent variables.

2.2.3 Student Performance on CIL Item Types

As already noted, student performance on the three types of CIL items (large task, multiple choice, and constructed response items) was scaled to the common metric and these measures of student performance were considered to be dependent variables in some analyses.

2.2.4 Time Taken to Respond to Items

ICILS 2013 recorded the amount of time taken by students (in seconds) to respond to each test item. Time taken to respond to test items is used as a dependent variable in our analyses.

We used a number of other scales derived for ICILS 2013 for our analyses (Table 2.2). These are described in more detail in the relevant chapter of this report.

Table 2.2 ICILS 2013 scales used in this report

Chapters	Description of ICILS 2013 scale used
3	Students' confidence (ICT self-efficacy) in solving basic computer-related tasks (S_BASEFF)
3	Students' confidence (ICT self-efficacy) in solving advanced computer-related tasks (S_ADVEFF)
4	Students' interest and enjoyment in using computers and computing (S_INTRST)
4	Students' use of specific ICT applications (S_USEAPP)
4	Students' use of ICT for social communication (S_USECOM)
4	Students' use of ICT for exchanging information (S_USEINF)
4	Students' use of ICT for recreation (S_USEREC)
4	Students' use of ICT for (school-related) study purposes (S_USESTD)
4	Students' use of ICT during lessons at school (S_USELRN)
4	Students' reports on learning ICT tasks at school (S_TSKLRN)
5	Teachers' ICT self-efficacy (T_EFF)
5	Teachers' positive views on using ICT in teaching and learning (T_VWPOS)
5	Teachers' negative views on using ICT in teaching and learning (T_VWNEG)

Notes All ICILS scales referred to here are described in detail in chapter 12 of the ICILS 2013 technical report (Schulz and Friedman 2015)

2.3 Measures of Significance and Effect

In large-scale studies with many thousands of respondents, even small differences or correlations can be significant. An effect size provides a quantitative measure of the magnitude of the difference or correlation. In this report we use a "rule of thumb" measure of effect when we talk about the sizes of the statistically significant differences on either the CIL scale or the questionnaire scales as follows:

- We refer to the differences as "large" if the differences are larger than 50 points on the ICILS 2013 CIL scale (the international standard deviation was 100) or larger than five points on the ICILS 2013 questionnaire scales (the international standard deviation for these was 10);
- We refer to the differences as "moderate" if the differences are between 30 and 50 points on the ICILS 2013 CIL scale or between three and five points on the ICILS 2013 questionnaire scales;
- We refer to the differences as "small" if the differences are between 10 and 30 points on the ICILS 2013 CIL scale or between one and three points on the ICILS 2013 questionnaire scales; and
- We refer to the differences as "not meaningful" or "negligible" if the differences are less than 10 points on the ICILS 2013 CIL scale or less than one point on the ICILS 2013 questionnaire scales.

For correlations, we also provide Cohen's d as a measure of effect size. Cohen (1988) suggested the following labels for effect sizes for correlations:

- Strong if Cohen's $d = 0.8$;
- Moderate if Cohen's $d = 0.5$; and
- Insubstantial if Cohen's $d = 0.2$.

For further information about the development of the scales for ICILS 2013, and their psychometric properties, please refer to the ICILS 2013 technical report (Fraillon et al. 2015).

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Chapter 3
Student Achievement and Beliefs Related to Computer and Information Literacy

Abstract The 2013 International Computer and Information Literacy Study (ICILS) showed that female students demonstrated higher achievement in computer and information literacy (CIL) than male students in 12 of the 14 countries considered, with an average 19 scale points (or one-fifth of a standard deviation) difference across those 12 countries. An analysis of differential item functioning indicated that female students generally performed relatively better on tasks that involved communication, design, and creativity, while male students generally performed relatively better on more technical tasks, and those concerned with security. Female students took a little longer to complete the test than male students; this may have contributed to their better scores. While there were few differences between female and male students' basic information and communications technologies (ICT) self-efficacy, on average, male students recorded higher specialized ICT self-efficacy than female students in all 14 countries, and the difference was moderate to large in 12 of the 14 countries. General ICT self-efficacy was positively associated with both male and female CIL achievement to a similar extent in all 14 countries. Advanced ICT self-efficacy, however, was less strongly and less consistently related to CIL achievement.

Keywords Achievement · Computer and information literacy (CIL) · Differential item functioning · Gender differences · Information and communications technologies (ICT) · International Computer and Information Literacy Study (ICILS) · International large-scale assessments · Self-efficacy

3.1 Introduction

As noted in Chap. 1, many large-scale assessments in a range of countries have reported that, on average, female students achieve higher scores than male students on computer, digital, or ICT literacy assessments (the terminology varies but the constructs are similar). These results differ from what might be expected, given the preponderance of males working in information technology and enrolled in computer science courses. These results also differ from the reports of self-reported competencies in the early stages of the introduction of computer technology to school (Cooper 2006; Volman and van Eck 2001). Punter et al. (2017) suggested

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that there has been a change in the relative performance of female and male students that has accompanied a broader societal change in computer use, from technical to applications incorporating information management and communications that make use of the internet. They argued that the performance of female and male students on different types of task should be investigated. We begin this chapter with an overview of the gender differences reported in the ICILS 2013 international report (Fraillon et al. 2014), and then summarize some detailed analyses of differences between female and male students overall and on different types of task, as well as reported differences in self-efficacy.

3.2 Gender Differences in Overall Performance

As reported in the ICILS 2013 international report (Fraillon et al. 2014), the performance of female students was substantially higher than that of male students in 12 out of the 14 ICILS 2013 countries for which adequate data were collected (Table 3.1). The size of the difference ranged from small in the Czech Republic (12 scale points) to moderate in the Republic of Korea (38 scale points). In the remaining

Table 3.1 Differences in mean performance in computer and information literacy between male and female students

Country	Mean CIL scale score for male students	Mean CIL scale score for female students	Difference in scale scores (males – females)
Republic of Korea	517 (3.7)	556 (3.1)	−38* (4.1)
Slovenia	497 (2.8)	526 (2.8)	−29* (3.6)
Chile	474 (3.9)	499 (3.9)	−25* (4.8)
Australia	529 (3.3)	554 (2.8)	−24* (4.0)
Norway	525 (3.1)	548 (2.8)	−23* (3.5)
Lithuania	486 (3.8)	503 (4.2)	−17* (3.4)
Germany	516 (3.2)	532 (2.9)	−16* (3.8)
Croatia	505 (3.6)	520 (3.1)	−15* (3.5)
Russian Federation	510 (3.4)	523 (2.8)	−13* (2.4)
Slovak Republic	511 (5.1)	524 (4.8)	−13* (4.1)
Poland	531 (3.1)	544 (2.9)	−13* (3.7)
Czech Republic	548 (2.8)	559 (2.0)	−12* (2.7)
Thailand	369 (5.3)	378 (5.7)	−9 (5.6)
Turkey	360 (5.4)	362 (5.2)	−2 (3.8)

Notes Standard errors in parentheses. Because some results are rounded to the nearest whole number, some totals may appear inconsistent. *Significant differences ($p < 0.05$)
Source Fraillon et al. (2014)

two countries (Thailand and Turkey; in both these countries achievement levels were very low), the differences were negligible.

3.3 Gender Differences in Specific Skills

The probability of responding correctly to an item is generally assumed to be dependent only on a student's ability and not on any other characteristics of the students, such as gender. If an item is easier for a male student than a female student with the same ability, the item is showing differential item functioning (DIF) and will advantage male students in general. The sum of the DIF estimates over all items is zero. The sum of the DIF for certain groups of items may not always add up to zero, however, and can thus reveal that some types of items are easier for male students and others for female students, after taking their ability into account. Items that display large DIFs are usually excluded from the measurement scale during calculation of ability estimates. It is not possible to remove all items that show any DIF, however, and so most remaining items show smaller levels of DIF. DIF values for females were estimated for each of the items in the ICILS 2013 CIL assessment for each of the computer literacy domains/strands, and the estimates over the group of items were summed (Table 3.2).

On average, female students performed better than male students of the same ability when asked to create information and, to a lesser extent, when asked to transform information. Male students outperformed female students of the same

Table 3.2 Differential item functioning for male and female students by ICILS 2013 strand

Strand		Sum of DIF (female)	Gender DIF favors	Number of items
2.2	Creating information	−1.08*	Females	18
2.1	Transforming information	−0.45	Neither	11
2.3	Sharing information	−0.17	Neither	3
1.2	Accessing and evaluating information	−0.06	Neither	9
1.3	Managing information	0.09	Neither	4
1.1	Knowing about and understanding computer use	0.70	Males	10
2.4	Using information safely and securely	0.97*	Males	10
Total DIF		0.00	Neither	65

Note *DIF estimates > 0.5 of a logit

Table 3.3 Differential item functioning for male and female students by ICILS 2013 item type

Item type	Sum of DIF (female)	Gender DIF favors	Number of items
Large task	−1.72	Females	34
Multiple choice	0.48	Males	7
Constructed response	1.24	Males	24
Total DIF	0.00	Neither	65

ability on items that required knowledge about and understanding of computer use, and on items that concerned using information safely and securely.

These findings agree with those reported in Punter et al. (2017), who examined item bias using different methods; they concluded that overall, ICILS 2013 items showed little gender DIF.

The ICILS 2013 test consisted of three types of items: multiple response items, constructed response items, and large tasks. The large tasks ask students to create an information product, such as a poster, presentation, or website. For instance, students might be asked to use a simple website builder to plan and create a webpage, or to use online database tools to select and adapt information in order to create an information sheet for their peers. DIF was also explored for these item types (Table 3.3). Large tasks were found to be relatively easier for female students. Constructed response and, to a lesser extent, multiple choice items were found to be relatively easier for male students. This pattern was true within each of the domains of CIL.

Individual assessment items that favored female students generally required skills involving communication, design, and creativity. In comparison, those items favoring male students generally required less creative skills, but more technical skills and greater knowledge of security issues, such as knowing the purpose of a captcha and recognizing spam emails (Table 3.4).

3.4 Gender Differences in CIL Self-efficacy

To examine self-efficacy in ICILS 2013, students were asked to report how well they could do each of the following general CIL skills:

- Search for and find a file on a computer;
- Edit digital photographs or other graphic images;
- Create or edit documents (for example assignments for school);
- Search for and find information needed on the internet;
- Create a multimedia presentation (with sound, pictures, or video); and
- Upload text, images, or video to an online profile.

Table 3.4 ICILS 2013 assessment items with a gender differential item functioning estimate favoring male or female students of at least 0.1 of a logit, and the skills required by each item

ICILS 2013 item code	ICILS 2013 test unit	Item difficulty	Gender DIF estimate	Gender DIF favors	Description of skill
S08F	School trip	1.06	−0.17	Females	Create balanced layout of text and images for an information sheet
A10A	After school exercise	−0.37	−0.15	Females	Create an appropriate title design for a poster
B07B	Band competition	−3.01	−0.15	Females	Use software to make an image brighter
A10I	After school exercise	1.03	−0.15	Females	Exclude irrelevant information in a poster
A03Z	After school exercise	−2.84	−0.14	Females	Identify information that is risky to include on a public profile
S08B	School trip	0.14	−0.14	Females	Locate required times on website pages
A10D	After school exercise	0.15	−0.12	Females	Text and background colors contrast to support readability
B09D	Band competition	0.08	−0.12	Females	Text and background colors contrast to support readability
S01Z	School trip	−1.48	0.10	Males	Open a link in a new browser tab
A09Z	After school exercise	−0.31	0.10	Males	Modify the sharing settings of a collaborative document
A02Z	After school exercise	−0.10	0.11	Males	Navigate to a URL given as plain text
B03Z	Band competition	0.13	0.12	Males	Navigate to a text-based URL
S07Z	School trip	2.50	0.15	Males	Interpret and choose a search result based on two criteria
B02Z	Band competition	−0.70	0.16	Males	Explain the features that make one of two passwords more secure
S08D	School trip	0.65	0.17	Males	Convert a description of directions into a visual route on a map
A06C	After school exercise	2.27	0.17	Males	Identify that a link's URL does not match the URL displayed in the link text
B08Z	Band competition	0.46	0.19	Males	Recognize legal and technical issues associated with image use
A06A	After school exercise	1.70	0.20	Males	Identify that an email does not originate from the purported sender
A04Z	After school exercise	−0.16	0.32	Males	Identify the purpose of a captcha form

Notes Further explanation of the ICILS 2013 item codes, units, item difficulties, and skills required can be found in Fraillon et al. (2014)

In ICILS 2013, student responses to this set of items were combined into a self-efficacy scale for basic CIL skills. The scale was constructed to have a mean of 50 and a standard deviation of 10.

Female students reported significantly higher levels of general self-efficacy, on average, than male students in six countries (Table 3.5). In Chile and the Republic of Korea, the differences were significant but small, while in the Russian Federation, Croatia, Australia, and Thailand, the differences were negligible (although statistically significant). In the remaining eight countries there were no significant gender differences.

Similarly, in ICILS 2013, students were also asked to rate the level of their skills for a set of specialized CIL skills, and a self-efficacy scale for specialized CIL scales was constructed (again with a mean of 50 and a standard deviation of 10). The specialized skills were:

- Use software to find and get rid of viruses;
- Create a database (for example, using [Microsoft Access®]);
- Build or edit a webpage;
- Change the settings on the computer to improve the way it operates or to fix problems;

Table 3.5 National averages and gender differences for students' self-efficacy in basic CIL skills, as reported by students participating in ICILS 2013

Country	National averages for students' self-efficacy in basic CIL skills		
	Males	Females	Difference (males − females)
Chile	52 (0.3)	54 (0.3)	−2* (0.3)
Republic of Korea	48 (0.3)	50 (0.3)	−2* (0.3)
Russian Federation	51 (0.3)	52 (0.2)	−1* (0.3)
Croatia	52 (0.3)	53 (0.3)	−1* (0.3)
Australia	51 (0.2)	52 (0.2)	−1* (0.3)
Thailand	39 (0.4)	40 (0.4)	−1* (0.4)
Slovenia	53 (0.3)	54 (0.3)	−1 (0.4)
Slovak Republic	51 (0.3)	51 (0.4)	−1 (0.5)
Norway	52 (0.3)	51 (0.2)	1 (0.3)
Germany	50 (0.3)	49 (0.4)	1 (0.5)
Poland	54 (0.2)	54 (0.3)	0 (0.3)
Czech Republic	51 (0.2)	51 (0.2)	0 (0.3)
Lithuania	49 (0.3)	49 (0.3)	0 (0.4)
Turkey	44 (0.4)	44 (0.5)	0 (0.6)

Notes Standard errors in parentheses. Because some results are rounded to the nearest whole number, some totals may appear inconsistent. *Significant differences ($p < 0.05$)
Source Fraillon et al. (2014)

- Use a spreadsheet to do calculations, store data, or plot a graph;
- Create a computer program or macro (for example, in [Basic, Visual Basic]); and
- Set up a computer network.

In contrast to the findings for general CIL skills, on average, male students showed higher self-efficacy when rating their ability in specialized CIL skills than female students in all 14 countries (Table 3.6), and the gender differences were much larger. The size of this difference was large in Germany, Norway, the Slovak Republic, the Czech Republic, Poland, Slovenia, and Lithuania, and moderate in Croatia, Australia, Turkey, the Russian Federation, and the Republic of Korea. Only in Chile and Thailand were the differences rated as small.

In order to examine the association of students' CIL with ICT self-efficacy beliefs for this report, we computed correlation coefficients for each ICILS country by gender for basic skills (Table 3.7) and for specialized skills (Table 3.8), and calculated Cohen's *d* to provide an estimate of the strength of the association. Self-efficacy in basic skills was found to be strongly positively related to achievement for male students in six countries (Australia, Chile, Croatia, the Republic of Korea, the Slovak Republic, and Turkey) and for female students in four countries (the Republic of Korea, Lithuania, the Slovak Republic, and Turkey). In most other countries the association was found to be moderate, while the effect was small for female students in the Czech Republic and Germany. This finding is in contrast to previous studies that

Table 3.6 National averages and gender differences for students' self-efficacy in specialized CIL skills, as reported by students participating in ICILS 2013

Country	National averages for students' self-efficacy in specialized CIL skills		
	Males	Females	Difference* (males − females)
Germany	51 (0.3)	44 (0.4)	7 (0.5)
Norway	52 (0.3)	46 (0.3)	6 (0.4)
Slovak Republic	54 (0.3)	47 (0.4)	6 (0.5)
Czech Republic	51 (0.3)	45 (0.3)	6 (0.4)
Poland	52 (0.3)	46 (0.3)	6 (0.4)
Slovenia	54 (0.4)	49 (0.3)	5 (0.4)
Lithuania	53 (0.3)	48 (0.3)	5 (0.4)
Croatia	55 (0.3)	50 (0.3)	4 (0.4)
Australia	50 (0.3)	46 (0.2)	4 (0.3)
Turkey	52 (0.4)	48 (0.4)	4 (0.5)
Russian Federation	54 (0.3)	50 (0.3)	4 (0.3)
Republic of Korea	53 (0.2)	50 (0.2)	3 (0.3)
Chile	53 (0.3)	51 (0.4)	2 (0.4)
Thailand	48 (0.4)	46 (0.4)	2 (0.5)

Notes Standard errors in parentheses. Because some results are rounded to the nearest whole number, some totals may appear inconsistent. *All differences were significant ($p < 0.05$)
Source Fraillon et al. (2014)

Table 3.7 Correlation between student self-efficacy for basic skills and CIL achievement, by gender

Country	Correlations between student self-efficacy for basic skills and CIL achievement*			
	Males	Cohen's *d*	Females	Cohen's *d*
Australia	0.38 (0.03)	0.8	0.34 (0.03)	0.7
Chile	0.37 (0.03)	0.8	0.32 (0.03)	0.7
Croatia	0.37 (0.03)	0.8	0.30 (0.04)	0.6
Czech Republic	0.24 (0.03)	0.5	0.21 (0.03)	0.4
Germany	0.23 (0.04)	0.5	0.19 (0.04)	0.4
Republic of Korea	0.42 (0.02)	0.9	0.40 (0.03)	0.9
Lithuania	0.35 (0.03)	0.7	0.41 (0.03)	0.9
Norway	0.22 (0.04)	0.5	0.27 (0.03)	0.6
Poland	0.33 (0.02)	0.7	0.34 (0.03)	0.7
Russian Federation	0.30 (0.02)	0.6	0.26 (0.03)	0.5
Slovak Republic	0.36 (0.03)	0.8	0.38 (0.03)	0.8
Slovenia	0.30 (0.03)	0.6	0.24 (0.03)	0.5
Thailand	0.27 (0.03)	0.6	0.32 (0.03)	0.7
Turkey	0.36 (0.04)	0.8	0.38 (0.03)	0.8
Average for all countries	0.32 (0.01)	0.7	0.31 (0.01)	0.7

Notes Standard errors in parentheses. *All correlations were significant ($p < 0.05$). Effect sizes using Cohen's d are regarded as insubstantial if $d = 0.2$, moderate if $d = 0.5$, and strong if $d = 0.8$

have suggested that self-efficacy is not related to performance in CIL (for example, Siddiq et al. 2016).

Self-efficacy in specialized skills, however, was less consistently and less strongly related to CIL achievement (Table 3.8). While a number of the correlations for both male and female students reached statistical significance, the relationship was only found to be of moderate strength for males in Turkey. The strength of the relationship in all other countries was insubstantial.

These differences were noted in the ICILS 2013 international report (Fraillon et al. 2014). The report explains that the finding is not unexpected given the nature of the CIL assessment construct, which is framed around computer and information literacy skills that are not necessarily related to the more technical skills described in the specialized skills construct. Punter et al. (2017) also investigated ICT self-efficacy differences between male and female students, and concluded that the differences may arise as males tend to overestimate their abilities while females tend to underestimate their abilities.

Table 3.8 Correlation between self-efficacy for specialized skills and CIL achievement, by gender

Country	Correlations between self-efficacy for specialized skills and CIL achievement			
	Males		Females	
	Correlation	Cohen's *d*	Correlation	Cohen's *d*
Australia	0.10* (0.03)	0.2	0.05 (0.03)	0.1
Chile	0.10* (0.03)	0.2	−0.06* (0.03)	−0.1
Croatia	0.18* (0.03)	0.4	0.09* (0.04)	0.2
Czech Republic	0.04 (0.03)	0.1	0.04 (0.03)	0.1
Germany	0.05 (0.03)	0.1	−0.04 (0.04)	−0.1
Republic of Korea	0.20* (0.03)	0.4	0.16* (0.03)	0.3
Lithuania	0.12* (0.03)	0.2	0.09* (0.03)	0.2
Norway	0.01 (0.04)	0.0	−0.05 (0.04)	−0.1
Poland	0.12* (0.03)	0.2	0.04 (0.03)	0.1
Russian Federation	0.08* (0.02)	0.2	−0.02 (0.03)	0.0
Slovak Republic	0.11* (0.04)	0.2	0.06* (0.03)	0.1
Slovenia	0.03 (0.04)	0.1	0.02 (0.03)	0.0
Thailand	0.05 (0.04)	0.1	−0.04 (0.04)	−0.1
Turkey	0.24* (0.04)	0.5	0.17* (0.04)	0.3
Average of all countries	0.10* (0.01)	0.2	0.04* (0.01)	0.1

Notes Standard errors in parentheses. *Correlations were significant ($p < 0.05$). Effect sizes using Cohen's d are regarded as insubstantial if $d = 0.2$, moderate if $d = 0.5$, and strong if $d = 0.8$

3.5 Gender Differences in Time Taken to Respond to the Test

Another consistent finding in ICILS 2013 across all 14 countries was that male students spent less time responding to the test items, on average, than female students. On average, female students spent one to four seconds longer on each item than male students (Table 3.9).

Germany, the Republic of Korea, and Slovenia had relatively higher gender differences in the time taken to respond to items and also higher differences between male and female students' average performance on the assessment (Table 3.9). Thailand, Lithuania, and the Russian Federation recorded much smaller (though still statistically significant) differences in average response times for male and female students, but varied somewhat in the size of their gender differences in achievement; this was small in Lithuania (17 points) and the Russian Federation (13 points), and non-significant in Turkey (see Table 3.1). These results suggest that response times for items may be a factor in the stronger average performance of female students on the ICILS 2013 CIL assessment. Taking more time to respond to these CIL items may be reflective of more careful and thoughtful responses, rather than being less

Table 3.9 Average time in seconds taken to respond per ICILS test item, by gender

Country	Average time (s) for students to respond to test items*		
	Mean response time males	Mean response time females	Difference (males − females)
Australia	34 (0.4)	37 (0.4)	−3 (0.4)
Chile	35 (0.5)	38 (0.4)	−2 (0.5)
Croatia	36 (0.6)	39 (0.5)	−3 (0.5)
Czech Republic	40 (0.5)	43 (0.4)	−3 (0.4)
Germany	37 (0.6)	40 (0.4)	−4 (0.6)
Republic of Korea	27 (0.5)	31 (0.6)	−4 (0.7)
Lithuania	33 (0.6)	34 (0.6)	−1 (0.4)
Norway	36 (0.5)	39 (0.5)	−3 (0.5)
Poland	39 (0.4)	41 (0.4)	−2 (0.4)
Russian Federation	37 (0.5)	38 (0.5)	−1 (0.4)
Slovak Republic	36 (0.7)	38 (0.5)	−2 (0.4)
Slovenia	35 (0.5)	39 (0.5)	−4 (0.5)
Thailand	31 (0.6)	33 (0.7)	−2 (0.5)
Turkey	23 (0.6)	24 (0.6)	−1 (0.3)

Notes Standard errors in parentheses. *All differences were significant ($p < 0.05$)

familiar or less confident in their responses, or needing more time to identify the correct response, as is often the case in other assessments.

3.6 Summary

Research question RQ1 (Sect. 1.4) asked: What is the magnitude of the difference between male and female students in measured computer literacy overall, and for particular types of items?

The findings of ICILS 2013 clearly indicated that, on average, female students achieved higher scores for CIL than male students. This difference was statistically significant in 12 of the 14 countries considered, and averaged 19 scale points (or one-fifth of a standard deviation) across the countries reported here.

Within this overall pattern, we found that differential item functioning analyses indicated that female students generally performed relatively better on tasks that involved communication, design, and creativity skills. In contrast, male students generally performed relatively better on more technical tasks and those concerned with security, such as knowing the purpose of a captcha and recognizing spam emails. In addition, female students took a little longer to complete the test than male students; each item took students an average time of 35 seconds to complete, and female students took between one and four seconds longer to respond to items than male students.

Research question RQ2 (Sect. 1.4) asked: To what extent do female and male students differ in computer self-efficacy overall, and in particular aspects of computing?

We found few differences worthy of note between female and male students' basic ICT self-efficacy. Differences were significant in only six countries, and of small size in two of these countries. However, on average, male students recorded higher specialized ICT self-efficacy than female students in all 14 countries, and the difference was moderate to large in 11 of the 15 countries. General ICT self-efficacy was positively associated with CIL achievement similarly for both sexes in all 14 countries. Advanced ICT self-efficacy, however, was less strongly and less consistently related to CIL achievement.

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Chapter 4
Students' Interest and Enjoyment in, and Patterns of Use of ICT

Abstract Two of the groups of potential influences on the development of computer and information literacy (CIL) concern students' affective responses (how they feel and behave in response to those feelings) when interacting with information and computer technologies (ICT) and their opportunities to learn CIL. IEA's International Computer and Information Literacy Study (ICILS) 2013 revealed that female students achieved better CIL test scores than male students in most of the participating countries. The question then arises as to whether gender differences in the CIL performance of students are associated with differences in their affective responses to ICT and/or differences in their levels of ICT usage. These questions were investigated by analyzing data from the ICILS 2013 student assessments and student questionnaires. Male students notably reported significantly higher levels of interest in, and enjoyment of, ICT than their female peers in 13 of 14 ICILS countries, and interest-enjoyment also appeared to have a stronger relationship with achievement in CIL among male students than among female students. While there may be some gendered patterns of use of ICT that reflect different interests, these differences do not uniformly result in advantages or disadvantages for male or female students in terms of CIL achievement.

Keywords Affective beliefs · Computer and information literacy (CIL) · Gender differences · Information and communications technologies (ICT) · International Computer and Information Literacy Study (ICILS) · International large-scale assessments

4.1 Students' Interest and Enjoyment in Computers and Digital Technology

4.1.1 Affective Responses to ICT

There is general acceptance that increased interest in and enjoyment of a field will be associated with higher achievement in that field. Large-scale assessment studies, such as PISA, have found that students who report being more interested in a subject, such as science, reading, or mathematics, or who report greater enjoyment of a subject

E. Gebhardt et al., *Gender Differences in Computer and Information Literacy*,
IEA Research for Education 8, https://doi.org/10.1007/978-3-030-26203-7_4

than their peers, tend to score higher in tests of these subjects. However, the direction of these relationships is often unclear. For example, does engagement with, or greater enjoyment of reading result in higher achievement in reading, or do students with higher achievement in reading become more engaged with reading and thus derive greater enjoyment from reading than their peers (OECD 2002)? Similarly, greater use of ICT may be associated with increased levels of familiarity with computers, and thus CIL achievement may be related to greater opportunity to learn (OTL). However, analyses of cross-sectional data do not help to untangle the direction of such relationships.

In the early stages of the introduction of computer technology in workplaces, there was a focus on computer anxiety as an affective response to ICT. Computer anxiety was one of the subscales of the extensively used *Teachers' attitudes toward computers* questionnaire (Loyd and Gressard 1984). More recently, a wider range of affective factors, including motivation, have come to be seen as related to the uptake of, and outcomes from the educational use of ICT (Katz 2018). In this chapter, we make use of an ICILS scale that combines interest in and enjoyment of ICT use: interest-enjoyment in ICT.

A large-scale national survey of ICT literacy in Australia investigated the interactions of a very similar construct they described as "interest in and enjoyment of using ICT" with ICT literacy (a similar construct to CIL) in the context of personal characteristics and computer use (ACARA 2015). These interactions formed part of a model designed to explain gender differences in ICT literacy. Among other results, the analyses showed that:

- Male students were more likely than female students to consider computers to be important;
- Male students were more likely to report stronger interest in computers;
- Interest-enjoyment in computers was associated with both ICT self-efficacy and ICT literacy;
- Ratings of the importance of computers were associated with ICT self-efficacy, but not with ICT literacy;
- Male students had higher levels of ICT self-efficacy than female students; and
- Female students performed better than male students on ICT literacy (a similar construct to CIL).

4.1.2 Opportunity to Learn CIL

Since the First International Science Study (FISS; see IEA 2019), IEA studies have reported a consistent relationship between student achievement and OTL, which was interpreted as student exposure to instructional content (Comber and Keeves 1973; Elliott and Bartlett 2016). Schmidt et al. (2015) reported a consistent association between OTL and mathematics literacy across 62 educational systems.

Gender differences in OTL CIL prompt several questions. One of these concerns whether female students use ICT more frequently or more regularly than male students, or for different purposes. A consequential question concerns whether any such differences contribute to females' higher CIL achievement. Alternatively, it could be that students have more experience with specific aspects of computing and thus perform better on tasks related to those aspects. Previous research has certainly noted gender differences in patterns of use of various types of ICT and posited this as an explanation for gender differences in CIL performance and employment in the digital economy (Kaarakainen et al. 2018; Punter et al. 2017).

4.2 Gender Differences in ICT Interest and Enjoyment

ICILS 2013 found there was a significant difference between male and female students' ratings of interest and enjoyment in ICT in most countries, with male students reporting higher levels of interest and enjoyment, on average, than female students (Table 4.1). The difference was significant in all countries except Thailand and Chile. The magnitude of the differences in the remaining countries ranged from small in Turkey to large in Germany.

Table 4.1 National averages in ICT interest-enjoyment, by gender

Country	Students' interest in and enjoyment of using computers		
	Males	Females	Difference (males − females)
Germany	51 (0.3)	45 (0.3)	6* (0.4)
Czech Republic	53 (0.3)	47 (0.3)	6* (0.4)
Slovenia	53 (0.4)	47 (0.2)	5* (0.4)
Norway	52 (0.3)	47 (0.2)	5* (0.3)
Republic of Korea	48 (0.3)	43 (0.3)	5* (0.4)
Croatia	56 (0.3)	51 (0.2)	5* (0.3)
Australia	52 (0.3)	47 (0.3)	5* (0.4)
Slovak Republic	50 (0.4)	46 (0.3)	4* (0.5)
Lithuania	51 (0.3)	47 (0.3)	4* (0.4)
Poland	53 (0.3)	49 (0.3)	4* (0.4)
Russian Federation	49 (0.2)	46 (0.2)	3* (0.3)
Turkey	53 (0.4)	51 (0.4)	2* (0.5)
Chile	56 (0.4)	55 (0.3)	1 (0.4)
Thailand	50 (0.4)	50 (0.3)	0 (0.4)

Notes Standard errors in parentheses. Because some results are rounded to the nearest whole number, some totals may appear inconsistent. *Differences were significant ($p < 0.05$)
Source Fraillon et al. (2014)

4.3 Gender Differences in the Associations Between CIL and ICT, and Interest and Enjoyment in Using ICT

A significant moderate positive correlation was found between interest-enjoyment and achievement in CIL for male students in three of the 14 countries: the Slovak Republic, Thailand, and Turkey (Table 4.2). Interestingly, the correlation was weaker for female students in most countries, with effect size approaching moderate only in Turkey.

Thus, in most countries, we found there was support for the general assumption that male students are more interested in computers and enjoy using them to a greater extent than their female peers do, and that this interest and enjoyment has a positive, albeit moderate, influence on the performance of male students in CIL. Interest-enjoyment in ICT appears to have a stronger association with CIL achievement among male students than among female students. The correlations are not large, however, suggesting that other factors may be influencing CIL achievement.

Table 4.2 Correlations between interest-enjoyment in ICT and CIL by gender

Country	Correlation between students' interest in and enjoyment of ICT and CIL skills			
	Males	Cohen's *d*	Females	Cohen's *d*
Australia	0.19* (0.03)	0.4	0.11* (0.03)	0.2
Chile	0.15* (0.03)	0.3	−0.03 (0.03)	−0.1
Croatia	0.14* (0.03)	0.3	−0.01 (0.03)	0.0
Czech Republic	0.02 (0.03)	0.0	0.00 (0.04)	0.0
Germany	0.08* (0.04)	0.2	−0.03 (0.05)	−0.1
Republic of Korea	0.19* (0.03)	0.4	0.15* (0.03)	0.3
Lithuania	0.13* (0.03)	0.3	0.07* (0.03)	0.1
Norway	0.11* (0.03)	0.2	0.12* (0.04)	0.2
Poland	0.13* (0.03)	0.3	0.00 (0.03)	0.0
Russian Federation	−0.01 (0.03)	0.0	−0.10* (0.04)	−0.2
Slovak Republic	0.23* (0.03)	0.5	−0.01 (0.04)	0.0
Slovenia	0.14* (0.04)	0.3	0.05 (0.03)	0.1
Thailand	0.28* (0.03)	0.6	0.17* (0.03)	0.3
Turkey	0.29* (0.04)	0.6	0.21* (0.03)	0.4
Average of countries	0.15* (0.01)	0.3	0.05* (0.01)	0.1

Notes Standard errors in parentheses. *Correlations were significant ($p < 0.05$). Effect sizes using Cohen's d are regarded as insubstantial if $d = 0.2$, moderate if $d = 0.5$, and strong if $d = 0.8$

4.4 Gender Differences in Patterns of Use

Fairlie (2015) examined how differences in the time invested in computer use by male and female students could contribute to the gender gap in academic achievement. The results showed that the male students were less likely to use computers for schoolwork and more likely to use computers to play games than female students. Female students were found to be more likely to use computers for social networking and email communication than male students, an observation that has been noted in other studies (Cussó Calabuig et al. 2017; Punter et al. 2017). Where early research on computer use focused on whether or how frequently male and female students were using computers, and how that related to differences in achievement, the focus is now on how, and for what purposes, male and female students use computer technology.

4.4.1 Use of ICT Productivity Applications

In ICILS 2013, students reported how often they used a computer outside of school for each of the following activities that involved common productivity applications. Response categories ranged between never and every day.

- Creating or editing documents (for example, to write stories or assignments);
- Using a spreadsheet to do calculations, store data, or plot graphs (for example, using [Microsoft EXCEL®]);
- Creating a simple "slideshow" presentation (for example, using [Microsoft PowerPoint®]);
- Creating a multi-media presentation (with sound, pictures, video);
- Using education software that is designed to help with school study (for example, mathematics or reading software);
- Writing computer programs, macros, or scripts (for example using [Logo, Basic, or HTML]); and
- Using drawing, painting, or graphics software.

In Turkey, the Slovak Republic, the Czech Republic, and Poland, male students reported using these productivity applications more frequently than female students (Table 4.3). In the Russian Federation, Australia, Chile, and the Republic of Korea, female students reported more frequent use of these applications than male students. The differences in all countries were small.

For male students, the correlation between the frequency of using these productivity applications and their CIL achievement was positive, but insubstantial in size, only reaching moderate strength in the Republic of Korea (Table 4.4). For female students, all effect sizes were insubstantial, approaching moderate only in the Republic of Korea and Turkey.

Table 4.3 National averages in use of ICT productivity applications, by gender

Country	In and out of school use of ICT productivity applications by students		
	Males	Females	Difference (males −females)
Turkey	53 (0.4)	50 (0.4)	3* (0.5)
Slovak Republic	52 (0.3)	51 (0.3)	1* (0.4)
Czech Republic	50 (0.3)	49 (0.3)	1* (0.3)
Poland	51 (0.3)	50 (0.3)	1* (0.4)
Croatia	48 (0.3)	47 (0.3)	1 (0.4)
Slovenia	51 (0.4)	51 (0.3)	1 (0.5)
Norway	49 (0.3)	49 (0.3)	0 (0.4)
Germany	46 (0.4)	46 (0.4)	0 (0.4)
Thailand	51 (0.4)	51 (0.3)	−1 (0.4)
Lithuania	51 (0.4)	52 (0.3)	−1 (0.4)
Russian Federation	53 (0.4)	54 (0.3)	−1* (0.3)
Australia	52 (0.3)	53 (0.2)	−1* (0.4)
Chile	50 (0.4)	51 (0.2)	−1* (0.4)
Republic of Korea	44 (0.4)	45 (0.3)	−1* (0.5)

Notes Standard errors in parentheses. Because some results are rounded to the nearest whole number, some totals may appear inconsistent. *Differences were significant ($p < 0.05$)
Source Fraillon et al. (2014)

4.4.2 Use of ICT for Social Communication

Students reported the frequency of their use of computers for the following social communication activities, responding between never and every day for each of the activities:

- Communicating with others using messaging or social networks (for example instant messaging or [status updates]);
- Posting comments to online profiles or blogs;
- Uploading images or videos to an [online profile] or [online community] (for example, Facebook or YouTube); and
- Using voice chat (for example, Skype) to chat with friends or family online.

In most countries, female students reported more frequent use of computers for these social communication activities (Table 4.5). The difference was generally small, except for in Chile, where the difference was moderate in size. In Croatia, Slovenia, Norway, Germany, and the Slovak Republic, there were no differences between male and female students' use of ICT for social communication. Turkey was the only country where male students reported using computers for social communication more frequently than female students.

Table 4.4 Correlation between using specific ICT applications and CIL, by gender

Country	Correlation between students' use of ICT applications and CIL skills			
	Males	Cohen's *d*	Females	Cohen's *d*
Australia	0.15* (0.03)	0.3	0.08* (0.03)	0.2
Chile	0.08* (0.03)	0.2	0.03 (0.03)	0.1
Croatia	0.18* (0.04)	0.4	0.08* (0.03)	0.2
Czech Republic	0.09* (0.03)	0.2	0.08* (0.03)	0.2
Germany	0.10 (0.07)	0.2	0.11* (0.06)	0.2
Republic of Korea	0.22* (0.03)	0.5	0.20* (0.03)	0.4
Lithuania	0.11* (0.04)	0.2	0.05 (0.04)	0.1
Norway	0.09* (0.04)	0.2	−0.03 (0.05)	−0.1
Poland	0.05 (0.04)	0.1	0.04 (0.03)	0.1
Russian Federation	0.10* (0.03)	0.2	0.05 (0.04)	0.1
Slovak Republic	0.06 (0.04)	0.1	0.05 (0.05)	0.1
Slovenia	0.02 (0.04)	0.0	0.05 (0.03)	0.1
Thailand	−0.01 (0.03)	0.0	0.05 (0.04)	0.1
Turkey	0.14* (0.04)	0.3	0.18* (0.04)	0.4
Average of countries	0.10* (0.01)	0.2	0.07* (0.01)	0.1

Notes Standard errors in parentheses. *Correlations were significant ($p < 0.05$). Effect sizes using Cohen's d are regarded as insubstantial if $d = 0.2$, moderate if $d = 0.5$, and strong if $d = 0.8$

Table 4.5 National averages in students' use of ICT for social communication, by gender

Country	Students' use of ICT for social communication		
	Males	Females	Difference (males − females)
Turkey	48 (0.4)	45 (0.5)	2* (0.5)
Croatia	52 (0.3)	52 (0.3)	0 (0.4)
Slovenia	50 (0.3)	51 (0.3)	0 (0.4)
Norway	50 (0.2)	50 (0.2)	0 (0.3)
Germany	49 (0.3)	50 (0.3)	−1 (0.4)
Slovak Republic	52 (0.3)	53 (0.3)	−1 (0.5)
Poland	51 (0.3)	52 (0.2)	−1* (0.4)
Czech Republic	51 (0.3)	52 (0.3)	−1* (0.4)
Thailand	45 (0.4)	47 (0.5)	−1* (0.5)
Russian Federation	53 (0.4)	55 (0.3)	−1* (0.4)
Republic of Korea	43 (0.3)	45 (0.3)	−2* (0.4)
Lithuania	51 (0.3)	52 (0.3)	−2* (0.4)
Australia	49 (0.3)	50 (0.2)	−2* (0.4)
Chile	49 (0.3)	52 (0.4)	−3* (0.4)

Notes Standard errors in parentheses. Because some results are rounded to the nearest whole number, some totals may appear inconsistent. *Differences were significant ($p < 0.05$)
Source Fraillon et al. (2014)

Table 4.6 Correlation between use of ICT for social communication and CIL, by gender

Country	Correlation between students' use of ICT for social communications and CIL skills			
	Males	Cohen's *d*	Females	Cohen's *d*
Australia	0.06 (0.03)	0.1	0.04 (0.03)	0.1
Chile	0.20* (0.03)	0.4	0.13* (0.04)	0.3
Croatia	0.18* (0.04)	0.4	0.08* (0.04)	0.2
Czech Republic	−0.01 (0.04)	0.0	−0.07* (0.03)	−0.1
Germany	0.06 (0.04)	0.1	−0.07 (0.05)	−0.1
Republic of Korea	0.14* (0.03)	0.3	0.16* (0.03)	0.3
Lithuania	0.14* (0.04)	0.3	0.13* (0.03)	0.3
Norway	0.02 (0.03)	0.0	0.02 (0.04)	0.0
Poland	0.06 (0.03)	0.1	0.08* (0.03)	0.2
Russian Federation	0.16* (0.03)	0.3	0.10* (0.04)	0.2
Slovak Republic	0.10* (0.04)	0.2	0.09* (0.04)	0.2
Slovenia	0.04 (0.03)	0.1	0.04 (0.03)	0.1
Thailand	0.25* (0.03)	0.5	0.31* (0.04)	0.7
Turkey	0.23* (0.04)	0.5	0.26* (0.04)	0.5
Average of countries	0.12* (0.01)	0.2	0.09* (0.01)	0.2

Notes Standard errors in parentheses. *Correlations were significant ($p < 0.05$). Effect sizes using Cohen's d are regarded as insubstantial if $d = 0.2$, moderate if $d = 0.5$, and strong if $d = 0.8$

The correlation between use of ICT for social communication and CIL was similar in many countries for male and female students (Table 4.6). The correlation was moderate for both males and females in Turkey and Thailand. In Slovenia, Norway, and Germany, where there were no gender differences in use of ICT for social communication, there were also no significant correlations between this type of ICT use and CIL achievement.

4.4.3 Use of ICT for Exchanging Information

Students reported on their frequency of use of ICT for exchanging information, using response categories ranging from never to every day. The activities included:

- Asking questions on forums or [question and answer] websites;
- Answering other peoples' questions on forums or websites;
- Writing posts for a personal blog; and
- Building or editing a webpage.

Table 4.7 National averages in students' use of ICT for exchanging information, by gender

Country	Students' use of ICT for exchanging information		
	Males	Females	Difference (males − females)
Turkey	53 (0.4)	50 (0.4)	4* (0.5)
Croatia	50 (0.3)	47 (0.3)	3* (0.4)
Czech Republic	49 (0.3)	48 (0.3)	2* (0.4)
Slovak Republic	52 (0.3)	50 (0.3)	1* (0.5)
Germany	46 (0.3)	45 (0.3)	1* (0.4)
Lithuania	53 (0.4)	52 (0.3)	1* (0.5)
Norway	46 (0.3)	45 (0.2)	1* (0.3)
Slovenia	52 (0.3)	51 (0.3)	1 (0.4)
Republic of Korea	49 (0.2)	49 (0.2)	0 (0.3)
Poland	50 (0.3)	51 (0.3)	−1 (0.4)
Thailand	54 (0.4)	54 (0.4)	−1 (0.5)
Chile	49 (0.3)	51 (0.3)	−1* (0.4)
Russian Federation	54 (0.3)	55 (0.3)	−1* (0.3)
Australia	47 (0.2)	48 (0.2)	−1* (0.3)

Notes Standard errors in parentheses. Because some results are rounded to the nearest whole number, some totals may appear inconsistent. *Differences were significant ($p < 0.05$)
Source Fraillon et al. (2014)

The distributions of gender differences were fairly symmetrical across countries: male students reported greater use of ICT for exchanging information in seven countries (Turkey, Croatia, the Czech Republic, the Slovak Republic, Germany, Lithuania, and Norway), and female students reported greater use of ICT for exchanging information in three countries (Chile, the Russian Federation and Australia) (Table 4.7). The differences were significant, but small in size for all those countries, except for Turkey, where the difference was moderate in size.

The correlations between the frequency of use of ICT for exchanging information and CIL did not show a clear pattern across countries (Table 4.8). While the correlations in some countries were statistically significant, an examination of effect sizes revealed that all correlations, other than a very small positive correlation for females in Thailand, were insubstantial.

Table 4.8 Correlation between use of ICT for exchanging information and CIL, by gender

Country	Correlation between students' use of ICT for exchanging information and CIL skills			
	Males	Cohen's *d*	Females	Cohen's *d*
Australia	−0.09* (0.03)	−0.2	−0.11* (0.03)	−0.2
Chile	−0.02 (0.03)	0.0	−0.07 (0.04)	−0.1
Croatia	0.07* (0.03)	0.1	−0.05 (0.03)	−0.1
Czech Republic	−0.10* (0.03)	−0.2	−0.10* (0.03)	−0.2
Germany	−0.09* (0.05)	−0.2	−0.08* (0.04)	−0.2
Republic of Korea	0.08* (0.03)	0.2	0.06* (0.03)	0.1
Lithuania	0.01 (0.03)	0.0	−0.04 (0.03)	−0.1
Norway	−0.08* (0.03)	−0.2	−0.07 (0.04)	−0.1
Poland	−0.03 (0.03)	−0.1	−0.06 (0.03)	−0.1
Russian Federation	0.03 (0.03)	0.1	−0.03 (0.03)	−0.1
Slovak Republic	−0.05 (0.04)	−0.1	−0.09* (0.04)	−0.2
Slovenia	−0.05 (0.03)	−0.1	−0.03 (0.04)	−0.1
Thailand	0.10* (0.04)	0.2	0.16* (0.04)	0.3
Turkey	0.03 (0.04)	0.1	0.05 (0.04)	0.1
Average	−0.02 (0.01)	0.0	−0.03* (0.01)	−0.1

Notes Standard errors in parentheses. *Correlations were significant ($p < 0.05$). Effect sizes using Cohen's d are regarded as insubstantial if $d = 0.2$, moderate if $d = 0.5$, and strong if $d = 0.8$

4.4.4 Use of Computers for Recreation

Students reported on their frequency of use of the internet for recreation. The response categories ranged from never to every day. The activities included:

- Accessing the internet to find out about places to go to or activities to do;
- Reading reviews on the internet of things they might want to buy;
- Playing games;
- Listening to music;
- Watching downloaded or streamed video (for example, movies, TV shows, or clips); and
- Using the internet to get news about things they were interested in.

Male students reported higher use of the internet for recreation than female students in six of the countries: Turkey, Poland, Norway, the Czech Republic, Slovenia, and Germany (Table 4.9). In Chile, Thailand, and the Republic of Korea the opposite pattern was observed, and female students reported greater use of ICT for recreation than male students. All differences were small in size.

Table 4.9 National averages in use of computers for recreation, by gender

Country	Students' use of computers for recreation		
	Males	Females	Difference (males − females)
Turkey	48 (0.4)	47 (0.5)	1* (0.5)
Poland	54 (0.3)	52 (0.3)	1* (0.5)
Norway	52 (0.2)	50 (0.3)	1* (0.3)
Czech Republic	52 (0.3)	51 (0.2)	1* (0.3)
Slovenia	50 (0.3)	49 (0.1)	1* (0.3)
Germany	47 (0.2)	46 (0.2)	1* (0.3)
Croatia	52 (0.4)	51 (0.2)	1 (0.4)
Russian Federation	55 (0.4)	54 (0.3)	1 (0.4)
Slovak Republic	52 (0.3)	52 (0.3)	0 (0.4)
Australia	50 (0.3)	50 (0.2)	0 (0.4)
Lithuania	48 (0.3)	49 (0.3)	−1 (0.4)
Chile	48 (0.4)	49 (0.3)	−1* (0.4)
Thailand	47 (0.3)	48 (0.4)	−1* (0.4)
Republic of Korea	47 (0.3)	48 (0.3)	−1* (0.4)

Notes Standard errors in parentheses. Because some results are rounded to the nearest whole number, some totals may appear inconsistent. *Differences were significant ($p < 0.05$)
Source Fraillon et al. (2014)

The correlation between use of computers for recreation and CIL was positive but the strength of the relationship was insubstantial in most countries (Table 4.10). In Thailand and Turkey, the correlations were of moderate size for females but smaller for males.

4.4.5 Use of ICT for Study Purposes

Students reported on their frequency of use of ICT for study purposes. The response categories ranged from never to every day. The activities included:

- Preparing reports or essays;
- Preparing presentations;
- Working with other students from the school;
- Working with other students from other schools;
- Completing [worksheets] or exercises;
- Organizing personal time and work;
- Writing about personal learning; and
- Completing tests.

Table 4.10 Correlation between use of computers for recreation and CIL, by gender

Country	Correlation between students' use of computers for recreation and CIL skills			
	Males	Cohen's *d*	Females	Cohen's *d*
Australia	0.09* (0.03)	0.2	0.11* (0.03)	0.2
Chile	0.13* (0.03)	0.3	0.15* (0.03)	0.3
Croatia	0.17* (0.03)	0.3	0.08* (0.03)	0.2
Czech Republic	0.03 (0.03)	0.1	0.04 (0.03)	0.1
Germany	0.09* (0.03)	0.2	0.07 (0.04)	0.1
Republic of Korea	0.13* (0.03)	0.3	0.15* (0.03)	0.3
Lithuania	0.08* (0.03)	0.2	0.10* (0.03)	0.2
Norway	0.06 (0.03)	0.1	0.10* (0.03)	0.2
Poland	0.11* (0.03)	0.2	0.17* (0.03)	0.3
Russian Federation	0.12* (0.03)	0.2	0.11* (0.04)	0.2
Slovak Republic	0.11* (0.04)	0.2	0.10* (0.04)	0.2
Slovenia	0.07* (0.03)	0.1	0.06 (0.03)	0.1
Thailand	0.17* (0.03)	0.3	0.25* (0.04)	0.5
Turkey	0.20* (0.03)	0.4	0.31* (0.03)	0.7
Average of countries	0.11 (0.01)	0.2	0.13 (0.01)	0.3

Notes Standard errors in parentheses. *Correlations were significant ($p < 0.05$). Effect sizes using Cohen's d are regarded as insubstantial if $d = 0.2$, moderate if $d = 0.5$, and strong if $d = 0.8$

Female students reported using ICT for study purposes significantly more frequently than male students in eight out of 14 countries (Table 4.11). These differences were generally small or negligible (>1.0).

Correlations between use of ICT for study purposes and CIL were generally not significant, or insubstantial where significant (Table 4.12).

4.5 Combined Effect of Interest and Enjoyment and Patterns of Use on CIL Achievement, by Gender

We applied a multiple regression analysis to estimate the net effect of interest-enjoyment, and assess differences in patterns of use on CIL achievement by gender. The averages of independent variables were fixed to zero within each country for these analyses (Tables 4.13 and 4.14).

For male students, the net positive effect of interest-enjoyment on CIL was significant and small (>1) in five out of 14 countries. In other countries where it was statistically significant, the strength of the relationship was negligible. For female students, the effect was statistically significant and meaningful only in two out of 14 countries. While the bivariate correlations (Table 4.2) suggested a somewhat

Table 4.11 National averages in use of ICT for study purposes, by gender

Country	Students' use of ICT for study purposes		
	Males	Females	Difference (males − females)
Turkey	53 (0.4)	53 (0.4)	0 (0.5)
Norway	53 (0.3)	53 (0.3)	0 (0.2)
Poland	49 (0.3)	49 (0.2)	0 (0.3)
Lithuania	47 (0.5)	47 (0.3)	0 (0.4)
Republic of Korea	44 (0.4)	44 (0.4)	−1 (0.5)
Chile	52 (0.3)	52 (0.2)	−1 (0.3)
Germany	46 (0.3)	47 (0.2)	−1* (0.4)
Czech Republic	48 (0.3)	49 (0.3)	−1* (0.3)
Slovak Republic	50 (0.3)	51 (0.3)	−1* (0.3)
Croatia	45 (0.3)	47 (0.2)	−1* (0.3)
Slovenia	48 (0.3)	49 (0.2)	−1* (0.3)
Australia	54 (0.4)	55 (0.3)	−1* (0.4)
Thailand	54 (0.3)	56 (0.3)	−1* (0.4)
Russian Federation	53 (0.4)	54 (0.2)	−2* (0.3)

Notes Standard errors in parentheses. Because some results are rounded to the nearest whole number, some totals may appear inconsistent. *Differences were significant ($p < 0.05$)
Source Fraillon et al. (2014)

Table 4.12 Correlation between use of ICT for study purposes and CIL, by gender

Country	Correlation between students' use of ICT for study purposes and CIL skills			
	Males	Cohen's *d*	Females	Cohen's *d*
Australia	0.16* (0.03)	0.3	0.10* (0.03)	0.2
Chile	0.03 (0.04)	0.1	0.00 (0.04)	0.0
Croatia	0.11* (0.03)	0.2	0.05 (0.04)	0.1
Czech Republic	−0.08* (0.04)	−0.2	−0.14* (0.04)	−0.3
Germany	0.06 (0.06)	0.1	0.01 (0.03)	0.0
Republic of Korea	0.16* (0.03)	0.3	0.09* (0.03)	0.2
Lithuania	0.03 (0.04)	0.1	−0.01 (0.04)	0.0
Norway	0.08 (0.05)	0.2	−0.01 (0.04)	0.0
Poland	0.00 (0.03)	0.0	−0.01 (0.04)	0.0
Russian Federation	0.03 (0.03)	0.1	0.08* (0.04)	0.2
Slovak Republic	−0.01 (0.04)	0.0	0.00 (0.04)	0.0
Slovenia	−0.04 (0.03)	−0.1	−0.05 (0.04)	−0.1
Thailand	0.04 (0.04)	0.1	0.06 (0.04)	0.1
Turkey	0.05 (0.04)	0.1	0.10* (0.04)	0.2
Average of countries	0.04* (0.01)	0.1	0.02 (0.01)	0.0

Notes Standard errors in parentheses. *Correlations were significant ($p < 0.05$). Effect sizes using Cohen's d are regarded as insubstantial if $d = 0.2$, moderate if $d = 0.5$, and strong if $d = 0.8$

Table 4.13 Multiple regression of CIL on interest and enjoyment and patterns of use for male students

Country	Intercept	Interest and enjoyment	Productivity applications	Use of ICT					R^2
				For social communication	For exchanging information	For recreation	For study purposes	During lessons at school	
Australia	528 (2.9)	1.4* (0.2)	0.9* (0.2)	0.6* (0.3)	−2.2* (0.3)	0.1 (0.3)	0.8* (0.2)	0.8* (0.3)	0.11* (0.02)
Chile	481 (3.1)	0.8* (0.3)	0.5 (0.3)	2.5* (0.4)	−2.2* (0.4)	0.6 (0.3)	0.2 (0.4)	−1.3* (0.3)	0.11* (0.02)
Croatia	506 (3.5)	0.7* (0.3)	1.1 (0.3)	1.2 (0.4)	−1.2* (0.3)	0.7* (0.3)	0.4 (0.3)	−0.7* (0.3)	0.08* (0.02)
Czech Republic	549 (2.7)	0.0 (0.2)	1.4* (0.3)	0.4 (0.3)	−1.3* (0.3)	0.4 (0.3)	−0.6* (0.2)	−0.6* (0.3)	0.06* (0.01)
Germany	519 (2.7)	0.5 (0.3)	1.0 (0.5)	0.7 (0.5)	−1.8* (0.4)	0.6 (0.5)	0.4 (0.5)	−0.4 (0.5)	0.05* (0.02)
Republic of Korea	517 (3.4)	1.3* (0.3)	1.4* (0.3)	1.1* (0.4)	−1.8* (0.4)	0.2 (0.3)	0.3 (0.2)	0.4 (0.2)	0.09* (0.02)
Lithuania	491 (3.6)	0.6* (0.3)	1.1* (0.3)	1.6* (0.4)	−1.1* (0.4)	0.1 (0.3)	0.0 (0.3)	−1.0* (0.3)	0.06* (0.02)
Norway	525 (3.1)	0.7* (0.2)	0.7* (0.3)	−0.2 (0.4)	−1.3* (0.3)	0.3 (0.4)	0.5 (0.4)	0.6 (0.4)	0.04* (0.02)
Poland	530 (3.1)	0.9* (0.3)	0.5 (0.3)	0.4 (0.3)	−1.1* (0.4)	0.8* (0.3)	−0.2 (0.3)	−0.5 (0.3)	0.04* (0.01)
Russian Federation	513 (3.4)	−0.6 (0.3)	0.8* (0.3)	1.3* (0.3)	−1.0* (0.3)	0.6* (0.3)	−0.2 (0.3)	−0.3 (0.2)	0.05* (0.01)
Slovak Republic	512 (4.6)	1.6* (0.3)	1.1* (0.4)	1.1* (0.4)	−1.6* (0.3)	0.6 (0.4)	−0.1 (0.4)	−0.4 (0.3)	0.08* (0.02)
Slovenia	496 (2.6)	0.8* (0.3)	0.4 (0.4)	0.5 (0.3)	−1.1* (0.3)	0.6 (0.3)	−0.4 (0.3)	0.1 (0.2)	0.04* (0.01)
Thailand	372 (4.8)	2.0* (0.3)	−0.9* (0.3)	3.3* (0.5)	−1.1* (0.4)	0.7 (0.4)	0.0 (0.4)	−0.7 (0.4)	0.14* (0.02)
Turkey	364 (4.7)	1.8* (0.3)	1.0* (0.3)	2.2* (0.4)	−2.3* (0.3)	1.1* (0.4)	−0.4 (0.4)	−0.5 (0.3)	0.16* (0.02)

Notes Standard errors in parentheses. *Differences were significant ($p < 0.05$)

Table 4.14 Multiple regression of CIL on interest and enjoyment and patterns of use for female students

Country	Intercept	Interest and enjoyment	Productivity applications	Use of ICT					R^2
				For social communication	For exchanging information	For recreation	For study purposes	During lessons at school	
Australia	557 (2.6)	0.6* (0.2)	0.2 (0.3)	0.7* (0.2)	−1.6* (0.3)	0.7* (0.2)	0.4 (0.3)	1.1* (0.4)	0.06* (0.01)
Chile	498 (3.7)	−0.5 (0.3)	0.6 (0.4)	1.4* (0.4)	−1.7* (0.4)	1.2* (0.4)	−0.2 (0.5)	−1.1* (0.3)	0.08* (0.01)
Croatia	519 (3.2)	−0.4 (0.3)	0.9 (0.3)	0.8 (0.3)	−1.1* (0.3)	0.5* (0.3)	0.2 (0.4)	−0.4 (0.3)	0.03* (0.01)
Czech Republic	561 (2.1)	0.0 (0.3)	1.4* (0.3)	−0.4 (0.3)	−0.8* (0.2)	0.8* (0.3)	−1.1* (0.2)	−0.4 (0.3)	0.07* (0.01)
Germany	535 (3.1)	−0.6 (0.4)	1.1* (0.6)	−0.6 (0.4)	−0.9* (0.4)	1.3* (0.5)	−0.4 (0.4)	−0.2 (0.4)	0.04* (0.02)
Republic of Korea	556 (3.1)	0.8* (0.3)	1.5* (0.3)	1.3* (0.3)	−1.5* (0.4)	0.4 (0.3)	−0.5* (0.3)	0.5* (0.2)	0.08* (0.02)
Lithuania	504 (4.3)	0.5 (0.3)	0.6 (0.5)	1.5* (0.4)	−1.3* (0.4)	0.7* (0.3)	−0.4 (0.4)	−0.9* (0.3)	0.05* (0.01)
Norway	552 (3.0)	0.8* (0.3)	−0.3 (0.4)	−0.2 (0.5)	−0.9* (0.4)	1.0* (0.4)	0.0 (0.5)	0.4 (0.5)	0.03* (0.01)
Poland	546 (2.9)	−0.4 (0.3)	0.5 (0.3)	0.6 (0.4)	−1.3* (0.4)	1.7* (0.3)	−0.7 (0.4)	0.1 (0.3)	0.05* (0.02)
Russian Federation	521 (2.7)	−1.2* (0.3)	0.1 (0.3)	1.0* (0.3)	−1.2* (0.3)	0.8* (0.3)	0.5* (0.3)	0.2 (0.2)	0.05* (0.01)
Slovak Republic	525 (5.1)	−0.5 (0.4)	1.4* (0.4)	1.3* (0.4)	−1.9* (0.3)	0.9* (0.4)	−0.6 (0.5)	−0.6 (0.4)	0.05* (0.02)
Slovenia	528 (2.8)	0.4 (0.2)	0.6* (0.3)	0.5 (0.3)	−0.7* (0.3)	0.5 (0.3)	−1.0* (0.4)	0.6* (0.3)	0.03* (0.01)
Thailand	379 (4.8)	1.1* (0.4)	−0.6 (0.4)	3.5* (0.6)	−1.9* (0.6)	2.1* (0.6)	−0.4 (0.5)	−0.3 (0.4)	0.14* (0.03)
Turkey	368 (4.2)	0.7* (0.3)	1.3* (0.4)	2.0* (0.4)	−2.7* (0.4)	2.1* (0.4)	−0.8* (0.3)	−0.3 (0.3)	0.16* (0.02)

Notes Standard errors in parentheses. *Differences were significant ($p < 0.05$)

stronger relationship between interest-enjoyment and CIL than the results of the multiple regression, the pattern of gender differences (with the relationship being positive for male students in a greater number of countries than was the case for female students) held across both sets of analyses.

The use of ICT productivity applications had a statistically significant and small positive effect on CIL in six countries for males and three countries for females.

Use of ICT for social communication had a small positive net effect in about half of the countries for both genders, with a moderate effect recorded in Thailand for both males and females.

While the relationship between use of ICT for exchanging information and CIL was negative in some countries and positive in others, the inclusion of other variables in the multiple regression resulted in ICT use for exchanging information having an almost uniform negative effect on CIL performance. For males, the effect was small to moderate and negative in all countries. For females, the net effect was small and negative in 10 countries.

In contrast, the positive relationship between using ICT for recreation and CIL that was suggested by the bivariate correlations disappeared for many countries once other variables were taken into account. For male students, the net effect was not meaningful in any country except for Turkey (compared to eight countries when referring to the bivariate correlations). For female students, the net effect was small and significant in six countries (compared to 11 countries when examining bivariate correlations).

The net effect of using ICT for study purposes was not meaningful for any group except for females in the Czech Republic, while using ICT during lessons at school was positively related to CIL only in Australia, and negatively related to CIL in Chile and Lithuania.

In total, the set of predictors explained between three and ten percent of the total variation in CIL achievement (Fig. 4.1). The percentage was highest in Thailand (14%) and Turkey (16%). In Australia, Chile, Croatia, and the Slovak Republic, the predictors collectively explained more of the variation in male performance than they did for female performance.

4.6 Summary

Research question RQ3 asked: To what extent do female and male students differ in their patterns of computer use and in their attitudes to computer technology?

As noted previously, male students reported significantly higher levels of interest in and enjoyment of ICT than their female peers in 12 of 14 ICILS countries, although these differences were usually small in magnitude. Interest and enjoyment, as measured in ICILS 2013, also appeared to have a stronger relationship with male student achievement in CIL than female student achievement.

The general assumption in educational research is that higher levels of interest and enjoyment are associated with higher achievement. Yet the findings for female

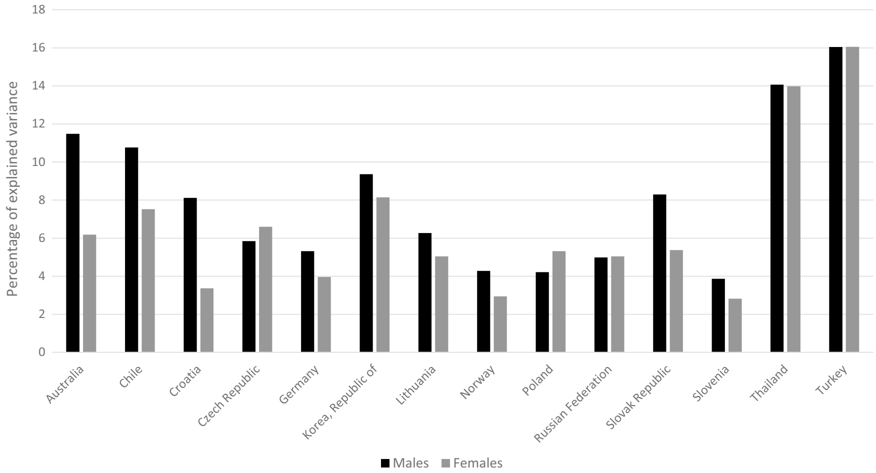

Fig. 4.1 Proportions of explained variance in CIL by interest and enjoyment and patterns of use of ICT

students do not seem to follow this pattern. Although female students outperformed males in CIL, their interest-enjoyment in ICT was lower, on average, than that of male students, and did not appear to be as strongly related to their CIL ability as these factors were for male students. These findings raise some interesting questions. What drives the higher performance of female students if not higher interest and enjoyment of the subject area?

Examination of gender differences in patterns of ICT use did not provide any clear answers to these questions either; while there were gender differences noted across the various types of uses of ICT, there was no pattern of advantage for males or females that would explain the differences in performance.

There were few differences between male and female students in their use of productivity applications. Those that reached significance were small, some in favor of males and some females, indicating no real overall pattern. Correlations between use of these applications and achievement were small but positive, more so for male than female students.

As reported in other studies, female students reported more frequent use of ICT for social communication in many, but not all countries (Fairlie 2015). In some countries (Croatia, Slovenia, Norway, Germany, and the Slovak Republic), there was no difference between male and female students' use of ICT for social communication, whereas, in Turkey, male students reported more frequent use of social communication channels, such as instant messaging, voice chat, and commenting on images and videos. More frequent use of ICT for social communication may only be a small factor in CIL achievement, with the correlations between frequency of this aspect of ICT use and CIL achievement being positive but significant with moderate strength for both males and females in only six of the participating countries. There were only limited gender differences in the strength of correlation between use of ICT for social communication and CIL.

For ICT use for exchange of information, there were no clear patterns of difference by gender; in some countries, male students reported greater use than female students, and, in other countries, female students reported greater use than male students. The correlations between use of ICT for exchange of information, such as answering queries or writing blog entries, and CIL achievement were similarly complex; correlations were significant and positive in a few countries and negative in others. In general, these associations were quite small, suggesting that higher participation in tasks such as answering or asking questions in forums or writing blog entries are not activities that contribute greatly to students' performance in formal assessments of CIL.

As reported in other studies (for example, Fairlie 2015), use of ICT for recreation tended to be higher among male students in at least half of the countries that participated in ICILS 2013, with the notable exceptions of Chile, the Republic of Korea, and Thailand, where female students reported higher usage of recreational ICT. It is interesting to note that, while use of ICT for such activities as playing games, listening to music, reading the news, or watching videos would, contrary to expectations, not appear to be associated with CIL, the correlations were actually positive in the majority of countries (with moderate effect sizes in five countries for female students and five countries for male students). In many respects, recreational use of ICT may reflect a greater degree of familiarity with ICT, or may afford these high users incidental opportunities to learn. Alternatively, those who are already proficient in CIL may be more likely to be everyday users of ICT for recreational purposes.

While other research has suggested that female students use ICT for study purposes more frequently than their male peers, there were differences in only five of the 14 countries examined here, and those differences were very small. For the most part, the correlations between use of ICT for study purposes, such as completing assignments and working with other students on shared tasks and taking tests, and performance on the CIL assessment, were not significant.

Use of ICT during school lessons did not show any strong relationship with CIL in the majority of countries, nor did it show any strong gender differences.

The relationships between patterns of use and CIL remained similar in a multivariate model where CIL was predicted by interest and enjoyment together with patterns of use of ICT. There were a few exceptions. Generally, the relationship of CIL with using ICT for exchanging information became more negative when taking the other variables into account and the positive relationship with using ICT for recreation became less positive for male students.

In summary, and to paraphrase another author (Punter et al. 2017), while there may be some gendered patterns of use of ICT that reflect different interests (females using ICT more for social communication and males using ICT more for recreation) these differences do not uniformly result in advantages or disadvantages for male or female students in terms of CIL achievement. For the most part, where correlations reached significance, they were significant among both male and female students and did not differ in magnitude.

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Chapter 5
Teacher Gender and ICT

Abstract The beliefs and attitudes of teachers towards information and communications technologies (ICT) in teaching and learning are central to the successful implementation of new technologies. While teachers are encouraged to integrate ICT into their teaching, there is evidence that the effectiveness of this integration depends to a large extent on teachers' preparedness to do so, which is directly related to their confidence and knowledge in using ICT, as well as their beliefs about the value of ICT in education. Female teachers using technology effectively provide a role model for young women at school, however previous studies have shown that female teachers are less likely to be using computers personally than their male counterparts. The International Computer and Information Literacy Study (ICILS) 2013 teacher questionnaire provides a rich resource of data on teacher characteristics in relation to computer and information literacy and technology by gender. Analyses of female and male teachers' experiences, dispositions, and uses of ICT indicate that any differences are small and inconsistent across countries. Female and male teachers in secondary school do not appear to differ greatly in the extent of their pedagogical use of ICT.

Keywords Computer and information literacy (CIL) · Gender differences · Information and communications technologies (ICT) · International Computer and Information Literacy Study (ICILS) · International large-scale assessments · Teachers

5.1 Introduction

Ertmer (1999) proposed two types of barriers to using ICT in teaching. First-order barriers include factors such as resources (both hardware and software), and second-order barriers include factors relating to teachers' expertise and interest, such as self-efficacy in using ICT, beliefs about student learning, and perceptions about the value of ICT in education. Teachers' responses to items addressing these issues in ICILS provide evidence to answer research question RQ4 (Sect.1.4): To what extent do female and male teachers differ in computer self-efficacy overall and in relation to particular aspects of computing?

E. Gebhardt et al., *Gender Differences in Computer and Information Literacy*,
IEA Research for Education 8, https://doi.org/10.1007/978-3-030-26203-7_5

Research question RQ5 (Sect.1.4) asked: To what extent do female and male teachers differ in their attitudes towards the use of computer technologies in school education? While teachers are encouraged to integrate ICT into teaching, there is evidence that their preparedness to do so determines the effectiveness of the integration rather than simply the existence of technology in the classroom (Buabeng-Andoh 2012). Anxiety and lack of confidence or competence often means that teachers revert to conventional learning techniques (Russell and Bradley 1997), and a number of studies cite female teachers' lower levels of computer use on a personal level and link this with lower levels of integration of ICT into their teaching practice (see, for example, Jamieson-Proctor et al. 2006; Wozney et al. 2006).

The ICILS teacher population was defined as any teacher teaching regular school subjects to students in grade eight in each sampled school and up to 15 teachers were selected at random from this population. The data for this chapter are derived from the teachers' responses to these surveys. Germany and Norway are not included in this chapter, as their data did not meet the sample requirements.

5.2 Teacher Gender

Cross-nationally, on average, more than two-thirds of the responding teachers were female, and female teachers were the majority in every country that participated in ICILS 2013 (Table 5.1). This was particularly evident in Lithuania (where 84% of teachers surveyed were female), the Russian Federation (83% female), the Slovak Republic (79% female), and Slovenia (78% female). Female teachers who are

Table 5.1 Percentage of teachers surveyed in ICILS 2013 that were female

Country	Percentage of teacher questionnaire respondents that were female (%)
Australia	63 (1.4)
Chile	61 (1.8)
Croatia	59 (1.6)
Czech Republic	75 (1.1)
Republic of Korea	65 (1.7)
Lithuania	84 (0.6)
Poland	75 (1.0)
Russian Federation	83 (1.0)
Slovak Republic	79 (1.1)
Slovenia	78 (0.9)
Thailand	62 (2.3)
Turkey	54 (1.7)
Average of countries	71 (1.1)

Note Standard errors in parentheses

confident about using computer and information technologies in their teaching may provide strong role models for the young women in their classes.

5.3 Experience in Using Computers

The ICILS 2013 teacher questionnaire asked teachers to describe how much experience they had in using computers for teaching purposes. Responses were in three categories: never, less than two years, and two years or more. The vast majority of teachers in all countries indicated that they had more than two years of experience in using computers (Table 5.2).

On average across countries, 81% of male teachers and 85% of female teachers reported having at least two years of experience in using computers. The largest difference in favor of female teachers was in the Russian Federation (17 percentage points) and there were also significant differences in favor of female teachers in Poland and Thailand (nine percentage points) and Croatia (six percentage points). The Czech Republic was the only country where there was a greater proportion

Table 5.2 National percentages of teachers' computer experience, by gender

Country	Percentage of teachers using computers for two years or more (%)		
	Males	Females	Difference (males – females)
Russian Federation	73 (3.2)	90 (0.9)	17* (2.9)
Poland	79 (1.9)	88 (1.1)	9* (2.2)
Thailand	72 (4.4)	81 (2.3)	9* (4.3)
Croatia	67 (1.8)	73 (1.4)	6* (2.4)
Republic of Korea	84 (2.3)	89 (1.2)	5 (3.2)
Lithuania	88 (2.1)	91 (1.1)	4 (2.4)
Slovak Republic	75 (2.2)	79 (1.4)	4 (2.6)
Australia	91 (1.1)	93 (0.7)	1 (1.2)
Chile	85 (2.0)	86 (1.6)	1 (2.6)
Turkey	82 (2.0)	82 (1.9)	0 (2.0)
Slovenia	81 (2.2)	80 (1.2)	−1 (1.8)
Czech Republic	90 (1.6)	84 (1.1)	−6* (1.9)
Average of countries	81 (0.7)	85 (0.4)	4* (0.7)

Notes Standard errors in parentheses. Because some results are rounded to the nearest whole number, some totals may appear inconsistent. *Differences were significant ($p < 0.05$)

of male teachers than female teachers that reported having more than two years of experience in using computers.

The ICILS 2013 international report (Fraillon et al. 2014) indicated that there were associations of a moderate size between teacher experience in using computers and frequency of use ($r = 0.34$, $d = 0.7$).

ICILS 2013 also disclosed the proportion of teachers in each country who reported using computers at least once a week at school when teaching, at school for other work-related purposes, and outside school for any purpose (Table 5.3). On average, around 60% of teachers used a computer at school when teaching, but this varied widely across countries. Australian teachers reported the highest levels of weekly computer use, and a significantly higher proportion of Australian female teachers than male teachers used a computer when teaching. The lowest level of computer use was in Poland, where fewer than half of either male or female teachers reported using computers on a weekly basis.

The largest gender differences could be seen in Croatia and in the Czech Republic; in both countries a substantially higher proportion of female than male teachers reported regularly using computers in the classroom. In Slovenia and Lithuania, the gender differences were similarly in favor of female teachers but smaller than in Croatia and the Czech Republic, and, in the Republic of Korea and the Russian Federation, more male teachers than female teachers used computers regularly in the classroom.

The use of computers at school for other work-related purposes was much higher than the use for teaching, reaching almost saturation point in Australia. On average across countries, just over 80% of teachers used computers at school for work-related purposes other than teaching. In the Russian Federation and Thailand, substantially more female than male teachers were weekly users of computers for other work-related purposes in school, while, in Turkey, the reverse was reported.

Similarly, the proportions of both male and female teachers using computers outside school for any purpose were high and there were few gender differences. Notably, the only significant differences were in Chile and the Russian Federation; in both countries, it was female teachers who reported a higher level of use of computers.

5.4 Confidence in Using ICT

As studies have shown (for example, SITES 2006: see IEA 2019; Law et al. 2008) confident teachers are more likely than less confident teachers to adopt ICT as part of their teaching repertoire. Confident female teachers are therefore more likely to use ICT than less confident female teachers, and confident female teachers may be important in ensuring that students of both sexes perceive ICT in the classroom as tools that are equally used by both male and female teachers. The ICILS teacher questionnaire asked teachers to rate their confidence in their ability to complete various tasks on a computer by themselves according to the following categories:

Table 5.3 Percentage of teachers reporting using a computer at least once a week, by gender

Country	At school when teaching			At school for other work-related purposes			Outside school for any purpose		
	Male	Female	Difference (males−females)	Male	Female	Difference (males−females)	Male	Female	Difference (males−females)
Australia	87 (1.3)	91 (0.8)	4* (1.5)	99 (0.3)	98 (0.6)	−1 (0.7)	97 (0.6)	98 (0.4)	0 (0.7)
Chile	59 (2.8)	64 (2.5)	4 (3.7)	82 (2.1)	83 (2.0)	1 (1.9)	89 (2.2)	95 (1.0)	6* (2.2)
Croatia	53 (2.1)	37 (1.9)	−17* (2.8)	71 (1.8)	72 (1.4)	1 (2.0)	92 (1.3)	90 (1.2)	−1 (1.6)
Czech Republic	75 (2.2)	62 (2.0)	−13* (2.6)	94 (1.2)	92 (0.9)	−2 (1.4)	95 (1.4)	96 (0.6)	1 (1.6)
Republic of Korea	65 (3.3)	81 (1.4)	17* (3.2)	91 (2.4)	95 (0.5)	4 (2.6)	81 (4.6)	84 (1.4)	3 (5.5)
Lithuania	61 (3.7)	67 (1.7)	7 (3.4)	85 (3.7)	90 (1.0)	5 (3.6)	94 (1.7)	93 (0.8)	−1 (2.0)
Poland	45 (2.9)	40 (1.9)	−4 (3.7)	79 (2.1)	76 (2.0)	−2 (2.5)	98 (0.5)	98 (0.5)	0 (0.7)
Russian Federation	62 (4.7)	79 (1.7)	17* (5.0)	69 (3.3)	90 (1.0)	20* (3.1)	78 (3.7)	85 (1.4)	8* (3.2)
Slovak Republic	62 (2.9)	57 (2.0)	−5 (3.5)	84 (2.0)	85 (1.2)	0 (2.3)	92 (1.6)	93 (0.8)	2 (1.8)
Slovenia	60 (2.6)	68 (1.5)	8* (2.8)	92 (1.5)	93 (0.7)	2 (1.4)	96 (1.0)	95 (0.5)	0 (1.0)
Thailand	51 (4.7)	49 (2.1)	−2 (4.6)	67 (4.5)	78 (2.8)	11* (4.5)	67 (4.4)	73 (3.5)	7 (5.4)
Turkey	51 (3.8)	44 (3.6)	−7* (3.1)	70 (2.7)	60 (2.2)	−11* (3.0)	90 (1.5)	92 (1.4)	2 (1.7)
Average of countries	61 (0.9)	62 (0.6)	1 (1.0)	82 (0.7)	84 (0.4)	2* (0.8)	89 (0.7)	91 (0.4)	2* (0.8)

Notes Standard errors in parentheses. Because some results are rounded to the nearest whole number, some totals may appear inconsistent. *Differences were significant ($p < 0.05$)

I know how to do this, I could work out how to do this, or I do not think I could do this. These tasks were:

- Producing a letter using a word processing program;
- Emailing a file as an attachment;
- Using the internet for online purchases and payments;
- Monitoring students' progress;
- Using a spreadsheet program (for example, [Lotus 1 2 3®, Microsoft Excel®]) for keeping records or analyzing data;
- Preparing lessons that involve the use of ICT by students;
- Finding useful teaching resources on the internet;
- Collaborating with others using shared resources such as [Google Docs®]; and
- Installing software.

The 14 items in this group of questions were used to derive a teachers' ICT self-efficacy scale. The scale was set to have an average of 50 and a standard deviation of 10. Higher values on the scale reflect greater levels of confidence (Table 5.4).

On average across the participating countries, there was a significant gender difference in favor of male teachers, although the magnitude of the difference was small. This was also true of the gender differences in Chile, the Slovak Republic, Australia, and Turkey. However, in the Czech Republic and Slovenia, and to a lesser

Table 5.4 National averages for the ICILS 2013 teacher ICT self-efficacy scale, by gender

Country	Teachers' reports on their ICT self-efficacy		
	Males	Females	Difference (males − females)
Czech Republic	54 (0.5)	48 (0.3)	6* (0.6)
Slovenia	54 (0.6)	49 (0.3)	5* (0.6)
Croatia	50 (0.6)	47 (0.4)	3* (0.7)
Poland	54 (0.6)	51 (0.3)	3* (0.6)
Chile	53 (0.6)	51 (0.4)	2* (0.7)
Slovak Republic	52 (0.6)	49 (0.2)	2* (0.7)
Australia	55 (0.3)	54 (0.3)	1* (0.4)
Turkey	49 (0.5)	48 (0.6)	1* (0.5)
Lithuania	51 (0.8)	50 (0.3)	1 (0.9)
Republic of Korea	53 (0.6)	53 (0.2)	0 (0.5)
Thailand	44 (0.9)	45 (0.7)	−1 (1.1)
Russian Federation	46 (0.9)	50 (0.4)	−3* (0.9)
Average of countries	51 (0.5)	50 (0.3)	2* (0.6)

Notes Standard errors in parentheses. Because some results are rounded to the nearest whole number, some totals may appear inconsistent. *Differences were significant ($p < 0.05$)

extent, in Croatia and Poland, gender differences were moderate to large (being three to six questionnaire scale score points), with male teachers expressing a higher level of self-efficacy than female teachers. Conversely, in the Russian Federation, the reverse was true; female teachers in the Russian Federation reported significantly higher levels of self-efficacy than their male colleagues.

5.5 Using ICT in the Classroom

Research question RQ6 (Sect. 1.4) asked: To what extent do female and male teachers differ in the ways in which they use computer technologies in their teaching? In ICILS 2013, teachers were asked whether or not they used ICT in their teaching of the reference class[1] during the current year (Table 5.5). As the teachers were a random sample, there was a variety of subjects being taught in those reference classes (for example, languages, mathematics, human sciences, physical sciences, creative

Table 5.5 National percentages of teachers using ICT with the reference class, by gender

Country	Teachers' reports of using ICT in their class (%)		
	Male	Females	Difference (males − females)
Thailand	71 (4.0)	66 (2.4)	4 (4.5)
Czech Republic	75 (2.1)	75 (1.6)	0 (2.3)
Turkey	57 (2.7)	59 (2.4)	−2 (2.6)
Australia	92 (0.9)	95 (0.7)	−3* (1.1)
Chile	80 (2.4)	85 (1.4)	−5* (2.1)
Croatia	60 (2.4)	65 (1.8)	−5 (3.1)
Slovak Republic	64 (2.9)	73 (1.8)	−9* (3.2)
Republic of Korea	73 (1.3)	85 (1.4)	−12* (1.7)
Poland	62 (3.2)	74 (1.4)	−12* (3.3)
Slovenia	72 (2.3)	84 (1.1)	−12* (2.3)
Lithuania	67 (3.0)	82 (1.1)	−15* (3.0)
Russian Federation	70 (2.2)	85 (1.0)	−15* (2.4)
Average of countries	70 (0.7)	77 (0.5)	−7* (0.8)

Notes Standard errors in parentheses. Because some results are rounded to the nearest whole number, some totals may appear inconsistent. *Differences were significant ($p < 0.05$)

[1]Teachers were asked to focus their responses to a series of questions about their teaching practices on only one class they taught, referred to as "the reference class." Teachers were instructed that this class was to be the one they taught on a particular day at a particular time.

arts, information technology, or vocational subjects), but, on average across the 12 countries, 70% of male teachers and 77% of female teachers said that they used ICT in the classroom. The difference between these percentages was significant.

Gender differences were significant in eight of the 12 countries, and were large in Lithuania and the Russian Federation (15 percentage points), in the Republic of Korea, Poland, Slovenia (12 percentage points), and the Slovak Republic (nine percentage points). In every country, a greater percentage of female teachers than male teachers reported using ICT in the classroom.

5.6 Developing ICT Skills in Students

Teachers who said they used ICT in their teaching were asked to indicate the extent of the emphasis they placed on developing their students' computer and information literacy (CIL). The 12 items formed an ICILS scale called developing students' CIL. As with other scales developed for ICILS, the mean of the scale is 50 and the standard deviation 10. Higher scores on the scale reflect stronger levels of emphasis on teaching these skills.

Teachers were asked to assess how much emphasis (according to the categories: strong emphasis, some emphasis, little emphasis, or no emphasis) they gave to developing ICT-based capabilities in:

- Accessing information efficiently;
- Evaluating the relevance of digital information;
- Displaying information for a given audience;
- Evaluating the credibility of digital information;
- Validating the accuracy of digital information;
- Sharing digital information with others;
- Using computer software to construct digital work products;
- Self-evaluating their approach to information searches;
- Providing digital feedback on the work of others;
- Exploring a range of digital resources when searching for information;
- Providing references for digital information; and
- Understanding the consequences of making information publicly available online.

Differences between male and female teachers tended to be small, but reached statistical significance in Australia, Chile, Lithuania, Slovenia, the Republic of Korea, the Slovak Republic, and the Russian Federation, resulting in a significant cross-national gender difference (Table 5.6). All differences indicated female teachers placed stronger emphasis on teaching these ICT-based capabilities.

Table 5.6 National average scale scores for emphasis on ICT skills scale, by gender

Country	Teachers' reports of their emphasis on ICT skills		
	Males	Females	Difference (males – females)
Thailand	51 (0.9)	49 (0.4)	2 (1.0)
Czech Republic	50 (0.5)	49 (0.4)	0 (0.6)
Turkey	50 (0.8)	50 (0.7)	0 (0.8)
Croatia	50 (0.6)	50 (0.4)	−1 (0.8)
Australia	52 (0.3)	53 (0.2)	−1* (0.3)
Chile	52 (0.7)	53 (0.5)	−1* (0.7)
Lithuania	46 (0.5)	47 (0.2)	−1* (0.5)
Slovenia	48 (0.5)	49 (0.3)	−1* (0.5)
Poland	48 (0.9)	50 (0.3)	−2 (1.0)
Republic of Korea	49 (0.4)	51 (0.3)	−2* (0.4)
Slovak Republic	48 (0.6)	50 (0.4)	−2* (0.7)
Russian Federation	48 (0.5)	51 (0.3)	−3* (0.5)
Average of countries	49 (0.2)	50 (0.1)	−1* (0.5)

Notes Standard errors in parentheses. Because some results are rounded to the nearest whole number, some totals may appear inconsistent. *Differences were significant ($p < 0.05$)

5.7 Teachers' Views About ICT

We also looked at what ICILS 2013 revealed about teachers' perceptions on the advantages and disadvantages of using ICT in schools, by gender. The ICILS teacher questionnaire asked teachers to rate their level of agreement (using the categories: strongly agree, agree, disagree, and strongly disagree) with a series of statements that represented both positive and negative aspects of using ICT for teaching and learning. Two scales were constructed (see Fraillon et al. 2014): the negative views on using ICT in teaching and learning scale and the positive views on using ICT in teaching and learning scale. Both these scales were standardized to have a mean of 50 points and a standard deviation of 10 points. Higher scores on the scales therefore reflect more negative or more positive views.

There were very few gender differences in the responses to statements related to negative views of using ICT in teaching and learning (Table 5.7). The only significant differences were in Croatia and Poland, and, while they were both small, they indicated that female teachers held slightly more negative views about ICT than male teachers.

While again there were only small gender differences in the national averages on the positive views scale in a number of countries, interestingly all indicated

Table 5.7 National averages for teachers with negative views on using ICT in teaching and learning, by gender

Country	Teachers' negative views on using ICT in teaching and learning		
	Males	Females	Difference (males −females)
Australia	49 (0.5)	48 (0.4)	1 (0.6)
Republic of Korea	53 (0.9)	52 (0.3)	0 (1.2)
Lithuania	51 (0.8)	51 (0.3)	0 (0.8)
Russian Federation	50 (0.8)	50 (0.4)	0 (0.8)
Slovenia	51 (0.5)	51 (0.3)	0 (0.5)
Thailand	51 (1.3)	51 (1.2)	0 (1.0)
Turkey	51 (0.5)	51 (0.5)	0 (0.6)
Chile	45 (0.6)	46 (0.7)	−1 (0.8)
Czech Republic	50 (0.5)	51 (0.4)	−1 (0.6)
Slovak Republic	49 (0.5)	50 (0.3)	−1 (0.5)
Croatia	50 (0.5)	51 (0.3)	−1* (0.5)
Poland	47 (0.5)	49 (0.3)	−2* (0.5)
Average of countries	50 (0.6)	50 (0.4)	0 (0.6)

Notes Standard errors in parentheses. Because some results are rounded to the nearest whole number, some totals may appear inconsistent. *Differences were significant ($p < 0.05$)

that male teachers held more positive views of ICT in teaching and learning than female teachers (Table 5.8). Interestingly, in Croatia and Poland, female teachers held significantly more negative views and in addition male teachers held significantly more positive views.

5.8 Explaining Variation in Teachers' Emphasis on Developing ICT Skills in Students

We also undertook in-depth investigation of the ICILS 2013 data in an attempt to explain differences in teachers' emphasis on developing students' ICT skills. We looked at male and female teachers separately, analyzing the combined effect of years of experience, teacher self-efficacy, and teachers' negative and positive views about using ICT in teaching and learning (Tables 5.9 and 5.10).

The variable for years of ICT experience for teaching was recoded into two dummy variables, with the reference category being two or more years of experience (as this was the most commonly recorded category). The first dummy category compared no experience with two or more years of experience, and the second dummy variable

Table 5.8 National averages for teachers with positive views on using ICT in teaching and learning, by gender

Country	Teachers' positive views on using ICT in teaching and learning		
	Males	Females	Difference (males – females)
Republic of Korea	50 (0.8)	47 (0.3)	2* (0.9)
Croatia	49 (0.4)	47 (0.3)	2* (0.6)
Poland	51 (0.5)	49 (0.3)	2* (0.5)
Turkey	55 (0.5)	54 (0.6)	1 (0.8)
Lithuania	50 (0.5)	49 (0.2)	1* (0.5)
Slovak Republic	48 (0.5)	47 (0.3)	1* (0.5)
Slovenia	48 (0.4)	47 (0.3)	1* (0.5)
Czech Republic	48 (0.5)	47 (0.3)	1 (0.6)
Thailand	57 (0.8)	56 (0.9)	1 (0.9)
Chile	56 (0.6)	55 (0.6)	0 (0.8)
Russian Federation	50 (0.9)	50 (0.3)	0 (0.8)
Australia	48 (0.4)	48 (0.4)	−1 (0.6)
Average of countries	51 (0.5)	50 (0.4)	1 (0.5)

Notes Standard errors in parentheses. Because some results are rounded to the nearest whole number, some totals may appear inconsistent. *Differences were significant ($p < 0.05$)

compared less than two years of experience with two or more years of experience. The other independent variables were scaled indices, centered around a mean of zero within each country.

Both male teachers (Table 5.9) and female teachers (Table 5.10) without experience in using ICT for teaching placed less emphasis on developing ICT skills in students than teachers with more than two years of experience in all countries. The effect of (lack of) experience on emphasis on ICT skills appeared to be stronger among female teachers than among male teachers.

The difference between the emphases placed on developing students' ICT skills by teachers with less than two years of experience against that of teachers with two or more years of experience in using ICT for teaching was statistically significant in all but one country (Turkey) for female teachers; conversely, for male teachers, this difference was non-significant in all but four countries (Croatia, the Republic of Korea, Lithuania, and the Slovak Republic). Together, these results suggest that the number of years of teacher experience in using ICT for teaching may be more influential on the extent to which female teachers emphasize developing ICT skills among their students than it is for male teachers.

Self-efficacy was an important predictor of the amount of emphasis placed on developing their students' ICT skills for teachers of both genders. Male and female

Table 5.9 Explaining the variation in male teachers' emphasis on developing ICT skills in students

Country	Intercept	Years of experience (none)	Years of experience (less than two years)	Self-efficacy	Negative views	Positive views	R^2
Australia	52 (0.3)	−11.6* (0.5)	−1.1 (1.5)	0.2* (0.0)	0.0 (0.0)	0.2* (0.1)	0.17* (0.04)
Chile	52 (0.5)	−10.8* (1.9)	−1.3 (1.3)	0.3* (0.1)	−0.1 (0.0)	0.1* (0.0)	0.23* (0.04)
Croatia	51 (0.7)	−11.8* (1.2)	−4.0* (1.6)	0.3* (0.0)	0.0 (0.1)	0.1* (0.0)	0.43* (0.03)
Czech Republic	49 (0.6)	−9.5* (1.6)	−1.6 (1.6)	0.3* (0.0)	0.0 (0.0)	0.1 (0.1)	0.18* (0.03)
Republic of Korea	49 (0.3)	−9.4* (0.9)	−4.8* (1.4)	0.3* (0.0)	0.1* (0.0)	0.3* (0.0)	0.35* (0.07)
Lithuania	46 (0.6)	−4.8* (2.0)	−4.4* (1.2)	0.3* (0.1)	0.0 (0.0)	0.1 (0.1)	0.29* (0.04)
Poland	48 (0.8)	−9.3* (1.0)	−0.7 (2.3)	0.4* (0.0)	0.0 (0.1)	0.1 (0.1)	0.27* (0.04)
Russian Federation	49 (0.4)	−6.3* (2.7)	−2.3 (1.3)	0.3* (0.1)	0.0 (0.1)	0.2* (0.0)	0.34* (0.04)
Slovak Republic	49 (0.5)	−9.5* (1.1)	−3.2* (1.5)	0.2* (0.0)	0.0 (0.1)	0.3* (0.1)	0.36* (0.04)
Slovenia	48 (0.5)	−9.9* (0.8)	−1.5 (1.7)	0.2* (0.0)	−0.2* (0.1)	0.1* (0.1)	0.32* (0.04)
Thailand	52 (0.9)	−7.0* (2.5)	−3.3 (2.5)	0.3* (0.1)	0.1 (0.0)	0.3* (0.1)	0.33* (0.05)
Turkey	51 (0.8)	−12.1* (1.3)	−2.5 (1.4)	0.4* (0.1)	−0.1 (0.1)	0.2* (0.0)	0.22* (0.04)

Notes Standard errors in parentheses. *Differences were significant ($p < 0.05$)

Table 5.10 Explaining variation in female teachers' emphasis on developing ICT skills in students

Country	Intercept	Years of experience (none)	Years of experience (less than two years)	Self-efficacy	Negative views	Positive views	R^2
Australia	53 (0.2)	−14.6* (2.0)	−2.5* (0.8)	0.2* (0.0)	0.0 (0.0)	0.2* (0.0)	0.18* (0.02)
Chile	54 (0.4)	−14.4* (1.5)	−2.7* (1.3)	0.3* (0.0)	0.0 (0.0)	0.2* (0.0)	0.24* (0.03)
Croatia	53 (0.4)	−12.3* (1.2)	−4.4* (0.8)	0.3* (0.0)	0.0 (0.0)	0.2* (0.0)	0.32* (0.02)
Czech Republic	51 (0.3)	−10.8* (1.1)	−4.1* (0.8)	0.3* (0.0)	0.0 (0.0)	0.2* (0.0)	0.22* (0.02)
Republic of Korea	52 (0.2)	−10.3* (2.3)	−4.7* (1.0)	0.3* (0.0)	0.1 (0.1)	0.4* (0.0)	0.28* (0.03)
Lithuania	48 (0.2)	−9.7* (1.9)	−2.8* (0.7)	0.3* (0.0)	0.0 (0.0)	0.1* (0.0)	0.23* (0.03)
Poland	51 (0.3)	−10.8* (0.7)	−2.1* (0.9)	0.3* (0.0)	0.0 (0.0)	0.2* (0.0)	0.23* (0.02)
Russian Federation	51 (0.2)	−7.5* (1.3)	−3.8* (0.7)	0.3* (0.0)	0.0 (0.0)	0.1* (0.0)	0.27* (0.02)
Slovak Republic	52 (0.3)	−11.2* (1.0)	−4.0* (1.0)	0.3* (0.0)	0.0 (0.0)	0.1* (0.1)	0.23* (0.02)
Slovenia	51 (0.2)	−11.6* (0.6)	−2.3* (0.7)	0.3* (0.0)	0.1 (0.0)	0.2* (0.0)	0.34* (0.02)
Thailand	50 (0.6)	−8.6* (1.3)	−6.1* (1.5)	0.3* (0.0)	0.1 (0.1)	0.2* (0.0)	0.25* (0.04)
Turkey	52 (0.8)	−11.6* (1.5)	−1.0 (1.8)	0.3* (0.1)	0.1 (0.0)	0.2* (0.1)	0.12* (0.02)

Note Standard errors in parentheses. *Differences were significant ($p < 0.05$)

teachers with higher levels of confidence placed more emphasis on teaching ICT skills to their students. On average, the regression coefficient was 0.3 scale points, meaning that an increase of one score point in self-efficacy was associated with an increase of 0.3 points in the scale of teacher emphasis on developing ICT skills among their students. Consequently, an increase of one standard deviation in self-efficacy (10 score points) was associated with three score points on the emphasis scale. This is a moderate effect. The effect was similar in size for both male and female teachers.

Negative views about using ICT in learning and teaching were generally not associated with teacher emphasis on teaching ICT skills, apart from male teachers in the Republic of Korea, where the association was positive, and Slovenia, where the association was negative. In both countries, the association between negative views of ICT and teacher emphasis on teaching ICT skills was small.

Positive views about using ICT in learning and teaching were positively related to teacher emphasis on teaching ICT skills to students in nine out of 12 countries for male teachers, and in all countries for female teachers. Significant effects were small to moderate.

Collectively, the independent variables explained between 12% (female teachers in Slovenia) and 43% (male teachers in Croatia) of the variance in teacher emphasis (see Fig. 5.1). In the majority of the countries, the collective contribution was larger for male teachers than it was for female teachers.

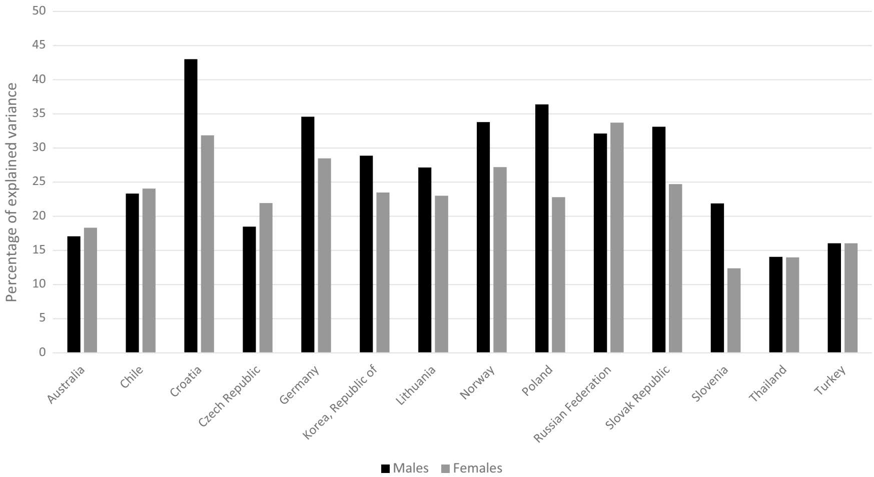

Fig. 5.1 Proportion of explained variance in providing emphasis on developing ICT skills in students by years of experience, teacher self-efficacy, and teachers' negative and positive views on using ICT in teaching and learning

5.9 Conclusions

The most pervasive conclusion from these analyses of female and male teachers' experience, dispositions toward, and use of ICT is that any differences are small and/or inconsistent across countries. These results should go some way towards dispelling any beliefs that female and male teachers in secondary schools differ in the extent of their pedagogical use of ICT.

On average, seven out of 10 lower secondary school teachers in the ICILS study were female. Female teachers, on average, reported slightly more experience than male teachers in using computers for teaching. Female and male teachers did not differ overall in either their positive or negative views regarding the use of ICT in education, but there were several countries in which male teachers expressed slightly more positive views than their female colleagues. There were differences between female and male teachers in their confidence in using computer technology. On average, male teachers reported higher ICT self-efficacy scores than those reported by female teachers, with a magnitude of a little less than one-fifth of a standard deviation. However, there were variations among countries in the magnitude of these differences and, in the Russian Federation, the female teachers reported higher self-efficacy than male teachers.

Teachers indicated whether they used ICT in their teaching of a randomly-selected reference class. On average, across the 12 countries, 70% of male teachers and 77% of female teachers said they used ICT in the classroom. There were only small differences in a few countries regarding the emphasis placed on teaching ICT-based capabilities, but where a difference was observed this was greater among female teachers than among male teachers.

The differing emphases that male and female teachers placed on developing ICT skills in students were positively associated with a teacher's years of experience in using ICT in the classroom, teacher self-efficacy, and positive views on using ICT in learning and teaching. Teachers' years of experience in using ICT in the classroom also appears to have a stronger relationship with female teachers' emphasis on such skill development than this factor does for male teachers. Other factors showed similar effects for both male and female teachers.

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Chapter 6
What Have We Learned About Gender Differences in ICT?

Abstract Gender differences among school students in the use of information and communications technologies (ICT) and their ICT literacy have been of interest over a number of years because ICT has become so central to education, work, and life in modern societies. This report presents results from detailed analyses of differences in computer and information literacy (CIL) across 14 countries. It finds that even though female students demonstrated higher levels of CIL than did male students there are some differences in specific aspects of CIL. Female students performed relatively better on tasks that involved communication, design, and creativity, and male students generally performed relatively better on more technical tasks. Moreover, male students were more confident than female students in their ability to perform specialized ICT tasks. Even though there were some gender differences in patterns of use of ICT, these differences did not appear to be related to differences in CIL. In addition, there were no appreciable differences between female and male teachers in their pedagogical use of ICT or in their dispositions towards its use.

Keywords Computer and information literacy (CIL) · Gender differences · Information and communications technologies (ICT) · International Computer and Information Literacy Study (ICILS) · International large-scale assessments

6.1 Introduction

There was once a pervasive belief that male students had an advantage over female students in both access to and proficiency in the use of information and communication technology (ICT). This report challenges those beliefs and suggests that a more nuanced interpretation is required. We analyzed data collected from both teachers and students from the IEA International Computer and Information Literacy Study (ICILS) conducted in 2013 (Fraillon et al. 2014) to determine the nature and extent of gender differences in computer use and beliefs about computers in schools across 14 countries.

E. Gebhardt et al., *Gender Differences in Computer and Information Literacy*,
IEA Research for Education 8, https://doi.org/10.1007/978-3-030-26203-7_6

6.2 Gendered Differences in CIL

We found that, on average, female students achieved higher scores for computer and information literacy (CIL) than male students. Although this difference was small in magnitude (about one-fifth of a standard deviation, on average) it was statistically significant in 12 of the 14 countries considered in ICILS 2013. However, differential item functioning (DIF) analyses of the data indicated that female students generally performed relatively better on tasks that involved communication, design, and creativity, and that male students generally performed relatively better on more technical tasks. Punter et al. (2017) reported similar results in a separate exploration of male and female student performance in ICILS 2013.

Examination of the relative ICT self-efficacy ratings (or confidence in using ICT) of female and male students regarding different aspects of ICT provides additional insight into this pattern of female superiority in CIL. Within the ICILS measure of ICT self-efficacy, it is possible to identify aspects that reflect general skills and aspects that reflect specialized skills. At the general levels of ICT self-efficacy, there were few differences between female and male students, however, male students generally assessed their ability to perform specialized ICT tasks significantly higher on the self-efficacy scale than did their female peers. Moreover, general ICT self-efficacy is more closely associated with CIL than specialized ICT self-efficacy for both female and male students in most countries.

The use of ICT applications that were related to information management and communication does not appear to be linked to increased competence in specialized and technical aspects of ICT, but is associated with competence in general aspects of ICT use. We therefore suggest that a construct such as computational thinking may produce different patterns of gender differences to those observed for CIL.

6.3 Response to and Use of ICT

This report also investigated differences between female and male students' affective responses to and use of ICT. Male students reported slightly higher levels of interest in and enjoyment of ICT than their female peers in 13 of 14 countries. In addition, interest and enjoyment appeared to be more strongly related to CIL among male students than among female students. Hence, the higher levels of CIL achieved by female students do not appear to be driven by interest and enjoyment of the area. Examination of gender differences in patterns of ICT use did not provide any insights into gender differences in CIL. There were few differences between male and female students in their use of productivity applications. Female students reported more frequent use of ICT for social communication in many, but not all, countries. More frequent use of ICT for social communication appeared to be associated with CIL to a small extent in about half of the countries. There was no clear pattern of gender differences in ICT use for exchange of information or in the associations between this form of ICT use and CIL. This relationship, however, was generally negative for both female and male students when taking into account the effects of differences in interest and enjoyment, and differences in other types of ICT use. Using ICT for recreation tended to be higher among male students in six of the countries, and was associated with higher CIL for both male and female students. Perhaps, recreational use of ICT reflects a greater familiarity with ICT, or perhaps those who are proficient in CIL are more likely to be everyday users of ICT for recreational purposes. However, this relationship was found in more countries for female students than for male students.

In summary, while there may be some gendered patterns of use of ICT these differences do not appear to be a plausible explanation of the differences in CIL between male and female students in terms of CIL achievement found by ICILS 2013. These findings are consistent with other research on the topic (Punter et al. 2017).

6.4 Teachers and ICT

The inescapable conclusion from our analyses of female and male teachers' experience, dispositions toward, and use of ICT is that any differences are small and inconsistent across countries. Female and male teachers in secondary schools do not appear to differ in the extent of their pedagogical use of ICT.

Female teachers, on average, reported slightly more experience in using computers for teaching than male teachers. Female and male teachers did not differ overall in either positive or negative views regarding the use of ICT in education, but, in some countries, female teachers reported slightly more positive views about the use of ICT in education than male teachers. Female and male teachers differed in their confidence (self-efficacy) in using computer technology. On average, male teachers recorded slightly higher ICT self-efficacy scores than female teachers, but this pattern differed among countries.

On average, 70% of male teachers and 77% of female teachers said they used ICT to support teaching in the classroom. There were small differences in a few countries in the amount of emphasis placed on teaching ICT-based capabilities to students, but where a difference was observed, it generally indicated that female teachers put greater emphasis on teaching ICT skills to students than male teachers did. For both female and male teachers, greater experience in using ICT in the classroom, higher ICT self-efficacy, and more positive views about using ICT in learning and teaching all contributed toward a stronger emphasis on developing students' ICT skills.

Given the relatively small differences between female and male teachers in their pedagogical use of ICT, it seems unlikely that teacher gender contributes to the observed gender differences in students' CIL performance. We were unable to link teacher characteristics or practices to student CIL, because the student and teacher samples in each school are independent in the ICILS assessments.

ICILS 2013 was the first major international assessment of ICT literacy in schools, and provided a wealth of information on student achievement in CIL, their attitudes toward and beliefs about ICT, as well as the respective attitudes and beliefs of their teachers. In the five years since the release of that report, the use of ICT has continued to grow at a rapid rate. Computer use has become even more ubiquitous, but has that translated into increased use in schools or affected the level of use by students in their schooling? Has the way in which students use computers at school changed over the past five years? Are there still gender differences in the same areas as in ICILS 2013?

ICILS 2018 (Fraillon et al. 2019) provides a link to ICILS 2013, which will enable researchers to monitor changes over the period from 2013 to 2018 for those countries that participated in both cycles. ICILS 2018 will also report on computational thinking, which can be thought of as the type of thinking used when programming a computer or developing an application for another type of digital device. Computational thinking is being able to recognize aspects of real-world problems that are amenable to computational formulation and develop algorithmic solutions to those problems (Fraillon et al. 2019). This therefore involves conceptualizing problems (through understanding digital systems, formulating problems, and collecting or representing data) and operationalizing solutions (through planning solutions to problems, and developing algorithms and programs). Data from this study will provide an opportunity to reflect on changes for male and female students over this five-year period, and will also provide an opportunity to examine the skills and beliefs of students in these new areas of assessment.

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