Digital Technologies in Education – Ireland in the International Context: Trends and Implications from PISA 2012-2018

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The Programme for International Student Assessment (PISA) is a study of the Organisation for Economic Co-operation and Development (OECD). Many organisations and individuals along with school leaders, teachers, students and parents contribute to its implementation.

In Ireland, the Educational Research Centre (ERC) is the PISA national centre, and works with the Department of Education and with a National Advisory Committee to implement PISA and produce national reports of the results.

The composition of the PISA National Advisory Committee can be found at: https://www.erc.ie/studies/pisa/pisa-national-advisory-committee-for-ireland/

Details on the international implementation of the study and results from all cycles can be found at the PISA international (OECD) website: https://www.oecd.org/pisa/

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List of acronyms and abbreviations

CIL	Computer and Information Literacy
CPD	Continuing Professional Development
CSPE	Civic, Social and Political Education
DEAP	(EU's) Digital Education Action Plan
DEIS	Delivering Equality of opportunity In Schools
DES	Department of Education and Skills (until late 2020)
DLF	Digital Learning Framework
DLP	Digital Learning Plan (of schools, to implement the DLF)
DoE	Department of Education (from late 2020)
DT	Digital Technology/Technologies
DSS	(Ireland's) Digital Strategy for Schools
EACEA	European Education and Culture Executive
ERC	Educational Research Centre
ESCS	Economic, Social and Cultural Status
ESS	Environmental and Social Studies
ETB	Education and Training Board
EU	European Union
ICILS	International Computer and Information Literacy Study
ICT	Information and Communication Technologies
IT	Information Technologies
NAMER	National Assessment of Mathematics and English Reading
OECD	Organisation for Economic Co-operation and Development
PDST	Professional Development Service for Teachers
PISA	Programme for International Student Assessment
SEN	Special Educational Needs
SPHE	Social, Personal and Health Education
SSE	School Self-Evaluation
STEM	Science, Technology, Engineering and Maths
TiE	Technology in Education (a team of the PDST responsible for resources and supports to enable schools to implement the DLF)
TLA	Teaching, learning, and assessment
TPL	Teacher Professional Learning
UNESCO	United Nations Educational Scientific and Cultural Organisation

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Section 1: Introduction

This report considers results from the 2012, 2015 and 2018 cycles of the Programme for International Student Assessment (PISA), a study of the Organisation for Economic Co-operation and Development (OECD) that has been implemented every three years since 2000. PISA assesses the knowledge and skills of 15-year-old students in reading, mathematics and science, as well as their behaviours, attitudes and beliefs, and home and school contexts.

The focus of this report is on digital technologies, in particular school infrastructure, capacity and policies; as well as student access, usage, perceived competence and autonomy. The PISA data provides an excellent basis for these analyses due to:

- the detailed and high-quality information that it provides on the digital technology resources available to students and schools and how they are used;
- the capability of the data to be used to examine change over time; and
- the possibility for the results for Ireland to be compared or 'benchmarked' against the averages of participating OECD and EU countries.

While PISA provides high-quality estimates of student outcomes, it should be noted that the study is designed to measure population-level contexts and is less sensitive to estimating differences between subgroups of a population. PISA is also a cross-sectional study that provides a 'snap-shot' of students at a particular time and cannot be used to assess change over time within the same individuals or schools. Furthermore, as the PISA test is not be suitable for small percentages of students (less than 5%) who have special educational needs and/or who have limited experience with the test language, these students are excluded from the study and, as such, the PISA data cannot be used to make inferences or to inform policies about these particular subgroups.

The OECD has tended to use the term 'information and communication technologies' or 'ICT' while in Ireland, the term 'digital technologies' or 'DT' has been the preferred term in recent years. In this report, we use both terms interchangeably.

It is hoped that this report will help to inform the implementation of the new national Digital Strategy for Schools to 2027 (Department of Education [DoE], 2022) at post-primary level, as well as encourage reflection and debate on Ireland's comparative position in the EU and more broadly the OECD with respect to digital technologies in education.

The data collection periods 2012-2018 coincide with the period prior to and during the implementation of the previous Digital Strategy for Schools (2015-2020; Department of Education and Skills [DES], 2015). The findings indicate strengths and challenges for consideration during the period of the new Strategy. Furthermore, ongoing analyses of the indicators described in this report in the next two cycles of PISA (2022, 2025) will inform progress on aspects of the new Strategy during its early and middle implementation phases.

Of course, profound change has occurred since February 2020 due to the impact of the COVID-19 pandemic in Ireland and internationally in February 2020. Nonetheless, these PISA digital technology indicators provide baseline and pre-pandemic benchmarks against which data from future cycles can be tracked and monitored in an international context which can be highly informative, since it allows progress to be monitored in two ways: Ireland relative to itself over time, and Ireland relative to international averages or comparators at a given point in time.

Focus of the present report

The research questions addressed in the present report are:

1. How does Ireland compare with the OECD and EU averages on PISA 2012, 2015 and 2018 indicators of digital technology (DT) access and use at home and school, and school DT infrastructure indicators? (Section 2)
2. How does Ireland compare with the OECD and EU averages on PISA 2018 indicators of schools' DT capacity and DT policies? (Section 3)
3. Are there differences within Ireland across schools in terms of their DT capacity and DT policies (by DEIS status, sector/gender composition, and urban/rural location)? (Section 3)
4. How does Ireland compare with the OECD and EU averages on PISA 2018 indicators of student DT use, competence and autonomy? (Section 4)
5. Are there differences within Ireland across student sub-groups (gender; junior/senior cycle; immigration status; Economic, Social and Cultural Status (ESCS); DEIS status; school sector/gender composition; and school urban/rural location) with respect to DT use, interest, competence and autonomy? (Section 4).

Section 5 summarises the findings and considers their implications.

The remainder of Section 1 provides a brief overview of the European and national contexts for the analyses; a review of recent findings from PISA as they relate to digital technologies; and a guide to interpreting the findings which includes a non-technical description of the design and survey content of PISA and how the PISA data is analysed for the current report.

European context

The European Commission recently published a flagship initiative, the Digital Education Action Plan (DEAP) 2021-2027.[1] The 2021-2027 plan is a policy initiative *to support sustainable and effective adaptation of the education and training systems of EU member states to the digital age.*[2] The DEAP builds on the previous 2018-2020 plan which had three priority areas (making better use of digital technology for teaching and learning; developing digital competencies and skills; and improving education through better data analysis and foresight).[3] The DEAP 2021-2027 sets out 13 actions under two priority areas[4,5]:

- *Fostering the development of a high-performing digital education ecosystem* (covering infrastructure, connectivity and digital equipment; effective digital capacity planning and development, including up-to-date organisational capabilities; digitally competent and confident teachers and education and training staff; high-quality learning content, user-friendly tools and secure platforms which respect e-privacy rules and ethical standards); and
- *Enhancing digital skills and competences for the digital transformation* (i.e. basic digital skills and competences from an early age; digital literacy, including tackling disinformation; computing education; good knowledge and understanding of data-intensive technologies, such as artificial intelligence (AI); advanced digital skills, which produce more digital specialists; and ensuring that girls and young women are equally represented in digital studies and careers).

1 https://education.ec.europa.eu/focus-topics/digital-education/digital-education-action-plan
2 https://digital-strategy.ec.europa.eu/en/policies/digital-learning
3 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2018:22:FIN
4 https://education.ec.europa.eu/focus-topics/digital-education/digital-education-action-plan
5 Beblavý et al. [2019, pp. 25-34], also provide a clear summary and critical review of the efforts of the European Commission in this area.

The European Commission notes that the COVID-19 pandemic has had the effect of speeding up the digital transformation as well as rendering it even more urgent to support digital transformation in order to sustain progress without further exacerbating current inequalities.6

The International Computer and Information Literacy Study (ICILS) has been identified by the Council of the EU as the means to monitor one of the seven targets of the Education and Training 2020 framework7 and constitutes an important resource for monitoring digital competence of lower post-primary students (it assesses students in grade 8, known as Second Year in Ireland). In the next cycle of ICILS (2023), which is conducted every five years, 30 countries (including 20 EU countries) will take part. Ireland does not currently take part in ICILS.

Two widely-used resources are among those that support the implementation of the 2021-2027 Plan:

- DigComp – a competency framework that describes digital competence in five broad areas (information and data literacy; communication and collaboration; digital content creation; safety; and problem-solving), and a total of 21 sub-competencies. The most recent version of DigComp, 2.2, elaborates on the basic 5/21 'conceptual reference model' with over 250 examples (Vuorikari et al., 2022).
- SELFIE – a free, customisable tool to help schools reflect on how they use digital technologies to support learning, with over 2.5 million users in 22,000 schools in 87 countries.[8] In 2021, a related tool, SELFIE for TEACHERS, was launched by the European Commission to help primary and post-primary teachers reflect on how they are using digital technologies in their professional practice.[9]

A recent report, *Digital Education at School in Europe* (European Commission/EACEA/Eurydice, 2019; referred to here as the 'Eurydice report' for short), provides a comparative analysis of curricula, policies and data as they pertain to digital education. Some of the key findings of that report are presented here as they help to place Ireland in the broader European context.

A striking feature of this report, which compares education systems at primary, lower and upper post-primary levels, is the diversity across the 43 countries/systems examined in terms of their digital technology policies, curricula and assessments. Of particular interest is that almost all of the countries in the report have a definition of digital competence unique to their education systems.

Unlike the majority of countries examined, Ireland does not (as at 2018/19) have a single common definition of digital competence – rather, its Digital Learning Framework (see the following section) draws on both EU's DigComp framework and UNESCO's ICT Competency Framework (UNESCO, 2011). In most other countries, the EU definition (*the confident, critical and responsible use of, and engagement with, digital technologies for learning, work, and for participation in society*) or a national definition have been adopted.

The Eurydice report includes an analysis of the extent to which eight of the 21 key sub-competencies of the DigComp framework are covered (as at 2018/19) at primary, lower, and upper post-primary education across 43 European countries/systems. This broad analysis reveals some gaps in the case of Ireland as well as in other countries (see Table 1.1). In Ireland, five of the eight competence areas examined are included at lower post-primary level, three at upper post-primary level, and one at primary. Ireland is most closely aligned with the European average picture at lower post-primary level, while its coverage of the competence areas is

6 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020SC0209&qid=1647943853396

7 In February 2021, the Council of the EU adopted a resolution on a strategic framework for European cooperation in education and training towards the European Education Area and beyond (2021-2030)', revising the education and training targets set out in the Education and Training 2020 strategic framework. Digital competence of pupils is one of the seven targets and ICILS is identified as a basis for monitoring this target such that by 2030 the percentage of low achievers is to be less than 15% (https://www.iea.nl/news-events/news/icils-recognized-official-eu-level-target).

8 https://schools-go-digital.jrc.ec.europa.eu/

9 https://education.ec.europa.eu/news/new-online-tool-to-support-teacher-digital-skills

comparatively lower at both primary and upper post-primary levels. Across all countries/systems, there was low coverage of two of the eight areas – identifying digital competence gaps, and managing digital identity. Countries that covered all eight competencies (at one or more of primary, lower and upper post-primary levels) in 2018/2019 comprised Bulgaria, Estonia, Germany, Greece, Malta and the UK (Wales and Northern Ireland).

Table 1.1. Summary of the coverage of eight of the 21 competence areas of DigComp in learning outcomes of national curricula, 2018/2019, for 43 European systems

Competence area		Primary			Lower Secondary			Upper Secondary		
		Ireland	*Total (43 systems)*		*Ireland*	*Total (43 systems)*		*Ireland*	*Total (43 systems)*	
			N	%		*N*	%		*N*	%
Information and data literacy	Evaluating data, information and digital content	**Yes**	27	62.8	No	31	72.1	No	25	58.1
Communication and collaboration	Collaborating through digital technologies	No	21	48.8	**Yes**	27	62.8	**Yes**	25	58.1
	Managing digital identity	No	8	18.6	No	16	37.2	No	12	27.9
Digital content creation	Developing digital content	No	30	69.8	**Yes**	38	88.4	**Yes**	32	74.4
	Programming/coding	No	20	46.5	**Yes**	31	72.1	**Yes**	31	72.1
Safety	Protecting personal data and privacy	No	19	44.2	**Yes**	28	65.1	No	28	65.1
	Protecting health and well-being	No	21	48.8	**Yes**	26	60.5	No	17	39.5
Problem solving	Identifying digital competence gaps	No	7	16.3	No	6	14.0	No	5	11.6

Source: Summarised from Figure 1.7 of European Commission/EACEA/Eurydice, 2019.

The Eurydice report notes that Ireland is one of just eight European education systems (along with Estonia, Spain, Croatia, Lithuania, Austria, Norway and Serbia) to have a framework describing the digital competencies or standards of teachers (in Ireland's case, this is referring to the Digital Learning Framework; see the next section.)

Assessment of digital competence is another area highlighted in the Eurydice report. As at 2018/19, just two of the 43 European countries/systems (Austria and Norway) had national assessments of digital competence at primary level. At post-primary level, about half of these countries/systems (Austria, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, France, Greece, Hungary, Latvia, Luxembourg, Malta, Norway, Poland, Portugal, Romania, Russia, Slovenia, and the United Kingdom [except Scotland]) had national assessments of digital competence. There is variation in approaches to assessment; for example, whether all or some students are assessed, whether it is voluntary or mandatory, whether it takes place at lower or upper post-primary levels or both.

Most commonly when assessment of digital competence is present at post-primary level, this is within the framework of official examinations to certify students' digital competences at the end of schooling. Despite this assessment, digital competence is frequently not included for all students in end-of-school certification. In the 20 systems where it is certified, it tends to be for students who have taken a digital competence-related subject or learning path or who have taken a related final examination. Just three countries (Bulgaria, Malta

and Romania) include digital competence on all students' end-of-schooling certification. As at 2018/2019 Ireland did not specify digital competence as part of the Leaving Certificate (European Commission/EACEA/Eurydice, 2019).

The Eurydice report also documents the extent to which countries implement technology-supported national assessments (for example for the purpose of overall monitoring of educational standards). This is the case in 10 of 43 countries/systems at primary level and in about half of these systems at lower and upper post-primary levels. As at 2018/19, Ireland did not implement technology-supported national assessments at any level. However since then, Computer Science has been introduced as a subject at senior cycle while optional short courses such as coding and digital media literacy have been introduced at junior cycle.[10][11]

In most countries, the official guidance on the assessment of digital competencies in the classroom is limited to learning outcomes, though five countries (Estonia, Ireland, Latvia, the United Kingdom – Northern Ireland, and Montenegro) have developed criteria and/or standards describing proficiency levels in digital competence or use of digital technologies that can be used by teachers in assessing students in the classroom at both primary and post-primary levels (European Commission/EACEA/Eurydice, 2019). In Ireland's case this refers to the Digital Learning Framework which is described in the next section.

Moving now to a broader context of digital technologies in the EU, Beblavý et al. (2019) have constructed an index of readiness for digital lifelong learning (IRDLL) and compared index scores across EU countries. This multi-component index, which is of relevance not only to education but also the broader societal and economic priorities and contexts of countries, was constructed through a combination of existing data and new data collected from surveys with national experts. Ireland ranks 12th of the 27 countries on the overall IRDLL index and is slightly above the EU average, with Estonia, the Netherlands, Finland, Luxembourg, Malta, Cyprus, Norway, Spain and Portugal occupying the top nine positions (in that order). Countries performing significantly below the EU average include Belgium, Poland, the Czech Republic, Romania, Greece, Italy and Germany.

Overall rankings aside, it is instructive to examine the components of the index and how Ireland's component scores vary in comparison with its overall score. The components making up the IRDLL, their relative weightings in computing the IRDLL, Ireland's rank, and the top five countries in each component are shown in Table 1.2. This shows that Ireland's overall ranking of 12th is characterised by relatively strong performance in learning participation and outcomes, and relatively weak performance in institutions and policies for digital learning as well as availability of digital learning.

10 https://www.curriculumonline.ie/Senior-cycle/Senior-Cycle-Subjects/Computer-Science/

11 https://www.curriculumonline.ie/Junior-Cycle/Short-Courses/

Table 1.2. Index of readiness for digital lifelong learning (IRDLL): component descriptions and weightings, Ireland's rank and top five ranking countries

Component	Description	Weight	Ireland's rank (of 27)	Top 5 (of 27)
Learning participation and outcomes	Learning outcomes, educational attainment and participation, participation in lifelong learning	30	8	Finland, Denmark, Sweden, Slovenia, Spain
Institutions and policies for digital learning	Institutions and policies, regulation and funding, educators and schools, governance and implementation	40	16	Cyprus, Estonia, Croatia, Netherlands, Malta = Portugal
Availability of digital learning	Attitudes towards digitalisation, accessibility of digital learning	30	16	Luxembourg, Sweden, Denmark, Netherlands, Finland
Overall		**100**	**12**	**Estonia, Netherlands, Finland, Luxembourg, Malta**

Source: Compiled from Beblavý et al. (2019).

Beblavý et al. (2019) make three recommendations in their report on the IRDLL. First, they recommend that the EU should be more strategic, building on the DEAP 2021-2027: "At the moment, a clear orientation, inspired by a holistic vision, is missing. Too often each Directorate-General (DG) tends to have its own perspective and agenda on the topic of digital learning." (p. 10). Second, they recommend that the EU creates a dedicated financial instrument to enable the streamlining and sustainability of digital learning initiatives. Third, they argue that the EU should further support Europe-wide understanding and the generation of knowledge about digital learning. This, they argue, should include an increase in research efforts for digital learning, since this area is still new.

Specifically with respect to Ireland, Beblavý et al. (2019) note that, regarding the first component (learning participation and outcomes), the national skills architecture is a strength. However they also highlight that "the country's performance is undermined by a lack of up-skilling initiatives to respond to digital transformation and the absence of a sustainable, long-term vision" (p. 57). Regarding the second (institutions and policies for digital learning), they comment that although digitisation has been a focus of the government since 2013, Ireland's average digital skills remain comparatively low, and they argue that this can be explained by the lack of sufficient support to accompany the necessary shift in pedagogical practices. Regarding the third (availability of digital learning), they comment that three current directions of work should be pursued further: efforts to highlight the deficiencies and challenges in the system; funding and co-ordinating efforts towards equal technology enhanced learning environments to enable the achievement of the national skills strategy; and targeted investment for digital skills education in schools.

National context

The national Digital Strategy for Schools (DSS) articulates an ambitious and broad-ranging vision. In the 2015-2020 strategy, the vision is articulated as follows:

...to realise the potential of digital technologies to enhance teaching, learning and assessment so that Ireland's young people become engaged thinkers, active learners, knowledge constructors and global citizens to participate fully in society and the economy. (DES, 2015, p. 5)

The new Digital Strategy for Schools to 2027 (DoE, 2022) was published in April 2022. Supporting the strategy is a comprehensive review of progress in this area during the implementation of the 2015-2020 strategy in an

accompanying 'baseline report' to the new strategy (Butler & Leahy, 2022). The authors comment: "While this vision [of the 2015-2020 DSS] continues to be relevant, there needs to be an assessment of the current use of digital technologies in classrooms and schools in Ireland in order to be able to plan in a sustainable way for the next iteration of the DSS, and to ensure that digital technologies are being used in more effective ways for quality, equitable and inclusive education" (Butler & Leahy, 2022, p. 36.).

The vision of the new DSS to 2027 is to *empower schools to harness the opportunities of digital transformation to build digital competence and an effective digital education ecosystem so as to develop competent, critically engaged, active learners while supporting them to reach their potential and participate fully as global citizens in a digital world* (DoE, 2022, p. 11.). In the new DSS, reference is made to the EU's Digital Education Action Plan 2021-2027, and it is stated that "Implementation of the Digital Strategy for Schools will be informed by these [DEAP] priorities in terms of the overriding objectives of this Strategy" (DoE, p. 11). The new DSS is also aligned with the Department of Education's statement of strategy 2021-2023 and the broader Digital Ireland Framework (see DoE, 2022, pp. 11-12 for more detail).

The new DSS is organised into three pillars, which contain some overlap, if not exactly aligning with, the EU's DEAP 2021-2027. The three pillars, which offer continuity to the themes in the previous (2015-2020) DSS, are:

- Pillar 1: Supporting the embedding of digital technologies in teaching, learning and assessment, with an emphasis on Teacher Professional Learning (TPL).
- Pillar 2: Digital technology infrastructure, including a commitment to build on what has been achieved with the previous strategy including technical support and procurement frameworks.
- Pillar 3: Looking to the future – policy, research and digital leadership, which makes reference to both system- and school-level leadership.

The specific implementation details (presumably to include targets and actions) are to be described in a forthcoming Implementation Plan to cover the period 2022-2024. A mid-term review is then to inform a second Implementation Plan to cover 2025-2027 (DoE, 2022).

The review by Butler & Leahy (2022) notes that a large majority of the actions identified by the 2015-2021 strategy Implementation Action Group (IAG) were achieved. They review the effectiveness of the strategy under its four themes. Key findings of this effectiveness review are summarised below[12]:

- Teaching, learning and assessment: The review notes that "One of the most significant accomplishments of the Digital Strategy for Schools (2015-2020) was the publication of the Digital Learning Framework (DLF) for primary and post-primary schools" (p. 9). (The DLF is described later in this section.) There is explicit curricular provision for the integration of DT into teaching, learning and assessment at primary, lower post-primary and upper post-primary levels (see Butler & Leahy, 2022, pp. 61-65 for a detailed description and discussion).
- Teacher professional learning (TPL): A key success of the implementation of the DSS to date has been the development and implementation of TPL by the Professional Development Service for Teachers (PDST) Technology in Education (TiE) team. These have taken a range of forms and modes, from "a two-hour session in a local education centre" to full post graduate courses, culminating in some 150,000 TPL interactions during the period 2017-2020 (Butler & Leahy, 2022, p.12, Table 2). Butler and Leahy (2022) highlight the significant increase across years in the levels of engagement by teachers in DT-related TPL over those three years. In addition, digital skills are now a core component of initial teacher education (ITE).
- Leadership, research and policy: Key actions under this theme included the ERC's longitudinal evaluation of the DLF; the establishment of structures to provide oversight and guidance on DSS implementation

12 Key achievements of the 2015-2021 Strategy are also summarised in Department of Education (2022, p. 9).

(for example through DoE Circulars to schools and a suite of resources developed by the PDST); and initiatives to support internet safety (e.g. Webwise).

- ICT Infrastructure: provision of €210 million funding through ICT equipment grants to schools (accompanied by procurement advice), and €13 million invested annually in improving school connectivity. Notably, these significant investments did not explicitly include funding for technical support and maintenance.

Some additional observations from Butler and Leahy (2022) are relevant to the analyses in the present report. First, they noted that in 38% of post-primary schools and 45% of primary schools assessed by Inspectors (DES, 2020), DT did not feature in teaching and learning. "This finding indicates that digital technologies are still underutilised in many schools and classrooms" (Butler & Leahy, 2022, p. 77).

Also, in their summary review of the findings of the ERC's longitudinal DLF evaluation (Cosgrove et al., 2019; Feerick et al., 2021, 2022), Butler and Leahy have highlighted that

> *among the key findings of the report was a lack of understanding of what constitutes effective practice and that schools tended to use multiple and mainly informal approaches to assess the level of practice within a chosen domain. This points to a need for further guidance to promote a more uniform understanding of levels of effective and highly effective practice for monitoring purposes.*

They also note that the findings point to the need to embed DT in assessment in particular. Describing the impact of DLF implementation as 'moderate' on teaching and learning practices, positive developments included an increase in collaboration among teachers and, particularly at post-primary level, a whole-school approach to embedding DT in teaching, learning and assessment.

Butler and Leahy (2022) also describe the outcomes of the consultation process that was undertaken by the DoE (open call; principals; teachers; parents; students) in the development of the new DSS.[13] While not discussed in detail here, it is worth noting some of the key points arising from these consultations:

- In the open call, there was a perceived need to prioritise development of digital literacy, digital citizenship and digital well-being; calls for a digital competence framework for teachers and students and support for school leaders; perceived need for targeted funding that addressed the imbalance between primary and post-primary schools including technical support; greater use of digital technologies for both assessment of and assessment for learning; enhanced monitoring and reporting of schools' Digital Learning Plans; and concerns expressed about inequity relating to specific groups such as children with special educational needs.
- Principals and teachers identified an urgent need for sufficient devices, better broadband, equipment maintenance and technical support, and procurement support; and indicated that there is a need for ongoing, sustained and sustainable TPL relating to digital technologies.
- Parents (like the open call responses) wanted strong home-school partnerships, development of digital competence, and were concerned about online safety.
- A large majority of students (80%) wanted greater use of digital technologies in school, and coding (23%) and Excel (20%) were the most popular skills students wished to develop.

Butler and Leahy (2022) identify five priorities from their effectiveness review for consideration under the new DSS:

- Development of curricular specifications to embed digital competencies development.
- Digitally supported assessment, both of learning, and for learning (i.e., summative and formative).

13 Reports on these consultations can also be found at https://www.gov.ie/en/publication/69fb88-digital-strategy-for-schools/.

- A coherent, flexible and sustainable model of TPL for teachers.
- Support for school leaders to incorporate DLF into school planning and improvement activities.
- Equitable access to broadband (particularly at primary level) in conjunction with effective technical support.

The notion of 'embedding', as described in the Digital Learning Framework (DLF; DES, 2017a, b; see also Feerick et al., 2022), is core to the implementation of the DSS, both in the 2015-2021 strategy and the new strategy to 2027 (DoE, 2022).

The DLF is a resource to guide schools on how best to effectively use digital technologies to transform their teaching, learning and assessment practices. It supports the DSS as well as other Department policies in a number of areas including curriculum reform and implementation, skills development, teacher education and improved learner outcomes. The DLF (DES, 2017a, b, p. 15) defines embedding digital technology as 'Moving beyond ICT integration, where digital technology is seamlessly used in all aspects of teaching, learning and assessment to enhance the learning experiences of all students.'

The DLF has two features worth noting. First, its structure is aligned with the existing school improvement and self-evaluation framework, *Looking at Our School* (DES, 2016a, b). This feature is important because it facilitates schools' improvement efforts in a range of areas to follow the same planning and monitoring practices. This is, perhaps, particularly useful in the area of digital technologies, where such activities tend to cut across multiple areas and functions of schools.

The Looking at Our School framework identifies two dimensions with four domains in each dimension:

- Teaching and Learning Dimension
  - Domain 1 – Learner Outcomes.
  - Domain 2 – Learner Experiences.
  - Domain 3 – Teachers' Individual Practice.
  - Domain 4 – Teachers' Collective/Collaborative Practice.
- Leadership and Management Dimension
  - Domain 1 – Leading learning and teaching.
  - Domain 2 – Managing the organisation.
  - Domain 3 – Leading school development.
  - Domain 4 – Developing leadership capacity.

Within each of the eight domains of the DLF, there is a set of standards, accompanied by statements of *effective* and *highly effective* practice. It is intended that schools' self-evaluation activities involve an assessment of the extent to which practice in the area(s) selected for review and improvement constitute effective/highly effective practice. The six-step process underpinning self-evaluation activities provides guidance and examples of gathering and reviewing evidence (DES, 2017a, b).

Second, the DLF is supported by a suite of resources, including planning guidelines, online and face-to-face courses, and case study/good practice videos, developed by Ireland's PDST TiE team.[14] These DLF-specific resources sit within a broader suite of resources to support the implementation of the Digital Strategy for Schools, also overseen by the PDST.[15]

14 www.dlplanning.ie

15 https://www.pdsttechnologyineducation.ie/en/

Building the evidence base relating to digital technologies in education for Ireland

As noted previously, the funding to support the implementation of the Digital Strategy for Schools is considerable, entailing a total investment of €210 million by way of an Infrastructure Grant for schools, which has been delivered in full since 2016. A commitment has also been made for a further €200 million for the period covering 2021-2027 as well as an annual investment of €13 million for improving school connectivity.[16] Given this level of funding, effective strategy monitoring and evaluation would seem important.

A significant gap in the evidence on the effectiveness and impact of the DSS is that there are no system-wide measures of the levels of students' or teachers' digital knowledge, skills or competence. As noted previously, Ireland does not participate in the International Computer and Information Literacy Study (ICILS) although the new DSS states that consideration for participation in the next cycle of ICILS in 2028 will be undertaken during the implementation of the strategy. Moreover, there is currently no national assessment of computer and information literacy that is capable of describing or monitoring standards. This suggests that a priority for the DoE to consider during the lifetime of the strategy is the adoption of the DigComp (or other competence) framework and to establish an assessment-based evaluation and monitoring programme based on this framework. This topic is revisited in Section 5.

The present report aims to go some way towards addressing the evidence gap through the analysis of relevant available data from PISA. It should be noted that although PISA gathers information from nationally representative samples of schools and students, it is not designed specifically to evaluate national initiatives such as the DSS. On the other hand, its rich internationally comparative data may well serve an enlightenment function (Kellaghan & Greaney, 2001; Plomp et al., 2003), to encourage reflection and debate nationally as the 2021-2027 strategy is implemented.

Recent findings on digital technologies from PISA

In this section, we focus on results from the OECD's (2021) analyses of PISA 2018. It should be noted that these data were collected prior to the onset of the COVID-19 pandemic and there are likely to have been some changes in digital behaviours, such as time spent on the internet, in the intervening years. Findings of recent analyses of ICT measures gathered in PISA are described elsewhere (e.g. Cosgrove et al., 2019; Feerick et al., 2021; McAteer et al., 2021; McKeown et al., 2019; Odell et al. 2020; Juhaňák et al., 2019; Park & Weng, 2020) and are not considered here.

The OECD (2021) reported, as one might expect, that time spent on the internet has increased significantly since 2012. However, 15-year-old students in Ireland spent considerably less time on the internet during school time (4 hours per week) than the OECD average (8 hours per week). The 4 hour per week figure for Ireland for 2018 is substantially lower than many European countries including Denmark (18), Estonia (9), Finland (9), Italy (7), Poland (8), Slovak Republic (9) and Slovenia (7); and lower than that for Spain (6) and the UK (6) (Table B1.2).[17] The changes since 2012 suggest that the gap between Ireland and the OECD average on this indicator is widening over time. In 2012, the average hours per week for Ireland and the OECD respectively were 2 and 3 hours. In 2018, they were 4 and 8 hours, respectively.

In contrast to this, hours per week on the internet *outside* of school time in 2018 were similar in Ireland (28) compared with the OECD average (27), as compared with 13 and 18 hours per week in 2012 for Ireland and the OECD, respectively (OECD, 2021, Table B1.1).

16 https://www.gov.ie/en/press-release/d32fc-minister-foley-announces-development-of-a-new-digital-strategy-for-schools/

17 Data are not available for some European countries including Germany and Portugal, due to the fact that these ICT survey questions were not administered across all EU countries in all three cycles (2012, 2015, 2018).

Since PISA 2009, the percentage of students with access to the internet at home has increased from 93% to 99% in Ireland and from 89% to 97% across the OECD on average. However, access to a device at home that can be used for schoolwork has decreased slightly in Ireland, from 93% in 2001 to 86% in 2018, while it has remained stable at the OECD average, 92% and 90%, respectively (OECD, 2021, Table B2.2). Reasons for this are unclear: it may be the case that the basic requirements of a 'device' have increased with recent advances in DT more generally, such as cloud computing; and/or these changes could reflect increased concerns regarding online safety and security.

The OECD (2021) computed a combined indicator of students' access to the internet *and* a device for schoolwork at home. In Ireland and on average across the OECD, rates of internet and device access for schoolwork at home are lower among students in disadvantaged schools relative to socioeconomically average or advantaged schools. In Ireland in 2018, the percentage of students with access to both of these resources in below, average and above average socioeconomic status (SES) schools were 79%, 87% and 90%, respectively, compared with OECD averages of 79%, 85% and 95%, respectively. It should be noted that this socio-economic disparity is by no means universal. For example, in Denmark, Estonia, Finland, Norway and Slovenia, the OECD reported that there is virtually no difference in the percentages of students with access to these resources at home by school socio-economic group in 2018.

Students' opportunity to learn digital literacy skills at school was lower in Ireland than across the OECD on average for the following: keyword searches online; evaluating trustworthiness of online information; comparing online sources and selecting the most relevant for schoolwork; applying short description of links in search results; and detecting phishing or spam emails. Students in Ireland, in contrast, reported a higher opportunity than on average across the OECD for understanding consequences of making information publicly available, and detecting whether information is subjective or biased (OECD, 2021, Table B2.6). These latter findings may be reflective of the impacts of Webwise, a PDST-led initiative to raise awareness of, and skills relating to, online safety and security.[18]

Results from the OECD (2021) also show that 15-year-olds in Ireland used computers in school less frequently than on average across the OECD, and at times considerably so, for each of a range of 10 educational activities such as browsing the internet for schoolwork, using computers for group work or communication, and practising or drilling (OECD, 2021, Table B6.14).

In PISA 2018, students were also asked, for English classes, whether a digital device had been used for teaching and learning. In Ireland, 23% indicated that both teachers and students used a device, 53% indicated that only the teacher used it, and 20% indicated that a digital device had not been used by either teachers or students. The respective OECD averages are 37%, 25% and 27% (OECD, 2021, Table B6.15). These results suggest that where digital devices are used in English class, they are much more likely to be used by teachers only in Ireland, compared with most countries across the OECD.

Recent research by Areepattamannil and Santos (2019) indicates that both perceived competence in ICT usage and perceived autonomy related to ICT usage (two of the measures considered in detail in the current report) were significantly positively associated with enjoyment of science, interest in broad science topics, science self-efficacy, and epistemological beliefs about science among PISA 2015 students from 42 countries. These findings demonstrate the additional insights that can be gleaned from PISA when one takes a broader view of outcomes – i.e. not solely focusing on test scores.

18 https://www.webwise.ie/.

Guide to interpreting the results

This section provides a non-technical and brief overview of the PISA design and analyses to guide interpretation of the results presented in Sections 2, 3 and 4. Technical information about PISA (sample design, technical standards, assessment framework, data processing and scaling, etc.) is described in detail in the OECD's technical reports on PISA (OECD, 2014, 2017, 2020). The national implementation of PISA is described in the main national reports on each cycle (McKeown et al., 2019; Shiel et al., 2016; Perkins et al., 2013).

As noted earlier, PISA is a study of the OECD. First conducted in 2000, it is administered every three years. The OECD Secretariat governs the study. It is implemented internationally by a consortium of institutions with expertise in the required areas (e.g. test development, psychometrics, translation, sampling, project management).[19] Each country has a national centre which oversees the translation and adaptation of instruments, fieldwork, data processing and coding, and, commonly, national analysis and reporting. The Educational Research Centre (ERC) is Ireland's national centre. The implementation of PISA in Ireland is guided by a national committee, chaired by a member of the Department of Education's Inspectorate.[20]

Schools selected to take part in the study in each country are sampled in accordance with technical procedures and standards so as to provide a nationally representative sample of students. Within schools, a set number of PISA-eligible students, based on their birth date[21], are selected at random from a list from each school.

Since 2015, PISA has been administered to students on computers. Students first take a two-hour assessment of reading, mathematics and science. Test questions take a variety of formats, ranging from multiple choice and drag and drop to more complex formats requiring a text response, interaction with a simulation, and so on. The assessments are guided by assessment frameworks which are developed by international subject expert groups. An important feature of PISA is that it is not designed to be a curriculum-based assessment. Rather, it aims to assess the knowledge and skills of young people as they are nearing completion of compulsory schooling in terms of their preparedness for further education, work and lifelong learning.

Following the test, students complete a questionnaire. Questionnaires are also completed by each participating school's principal and, optionally in some countries, by teachers and parents. The survey questionnaire content is also guided by international experts (see, for example, OECD's [2019] PISA 2018 assessment and analytic framework, which describes the frameworks for both the tests and the questionnaires). The policy and thematic priorities are established by the PISA Governing Board, which has a representative from each PISA country.

The number of participating countries/systems has steadily grown over the years (from 31 in 2000 to 84 in 2022). For the purposes of the present study, however, we are concerned with the OECD and EU averages, which are more stable than the international all-country PISA average.

The report draws entirely from self-reported survey questionnaire data and does not report on the test scores of students. In this sense it represents a move away from a strict or narrow focus on test scores as the main educational outcome of interest.

The questionnaire taken by students consists of a core component; there are also optional components which countries may elect to take. Section 2 of this report draws on data from both the optional ICT Questionnaire,

19 Further information on PISA is available here: https://www.oecd.org/pisa/

20 Ireland's national advisory committee membership is shown here: https://www.erc.ie/studies/pisa/pisa-national-advisory-committee-for-ireland/

21 In Ireland's case to date, PISA eligibility is based on year of birth. In PISA 2018 for example, where fieldwork took place in March-April, PISA-eligible students were those born in 2002.

which is completed by students, and the School Questionnaire, which is completed by principals. Section 2 examines comparative trends in digital technologies across three cycles of PISA: 2012, 2015 and 2018. The ICT questionnaire component has been administered to between 20 and 22 EU countries in 2012, 2015 and 2018, despite it being optional – this reflects the high level of interest internationally in the area of digital technologies, teaching and learning. Table 1.3 shows the countries included in the analysis for Section 2. The remainder of the report draws on data from PISA 2018 alone, collected from the School Questionnaire (administered in all participating countries) and the ICT Questionnaire (administered only in countries that selected this option). The slight variations in countries contributing to the EU and OECD averages should be borne in mind when interpreting the results presented in Sections 2, 3 and 4 of the report.

Table 1.3. List of countries included in the analyses in Section 2 of this report: 2012, 2015 and 2018

2012	2015	2018	EU
Australia	Australia	Australia	
Austria	Austria	Austria	X
Belgium	Belgium	Belgium	X
Chile	Chile	Chile	
Croatia			X
Czech Republic	Czech Republic	Czech Republic	X
Denmark	Denmark	Denmark	X
Estonia	Estonia	Estonia	X
Finland	Finland	Finland	X
	France	France	X
Germany			X
Greece	Greece	Greece	X
Hungary	Hungary	Hungary	X
Iceland	Iceland	Iceland	
Ireland	Ireland	Ireland	X
Israel	Israel	Israel	
Italy	Italy	Italy	X
Japan	Japan	Japan	
Korea	Korea	Korea	
Latvia	Latvia	Latvia	X
	Lithuania	Lithuania	X
	Luxembourg	Luxembourg	X
Mexico	Mexico	Mexico	
Netherlands	Netherlands		X
New Zealand	New Zealand	New Zealand	
Norway			
Poland	Poland	Poland	X
Portugal	Portugal		X
Slovak Republic	Slovak Republic	Slovak Republic	X
Slovenia	Slovenia	Slovenia	X
Spain	Spain	Spain	X
Sweden	Sweden	Sweden	X
Switzerland	Switzerland	Switzerland	
Turkey		Turkey	
	United Kingdom	United Kingdom	X
		United States	
Total EU: 20	**Total EU: 22**	**Total EU: 20**	
Total OECD: 32	**Total OECD: 31**	**Total OECD: 31**	

Notes. Croatia became an EU Member country 01 July 2013
Latvia became an OECD Member country on 01 July 2016
Lithuania became an OECD Member country on 05 July 2018
UK was a member of the EU up until January 31 2020
See https://www.oecd.org/pisa/aboutpisa/pisa-participants.htm for full information on PISA participants.

The digital-technology related indicators considered in this report are summarised in Table 1.4. Two of the measures (SCHCAP and SCHPOL) were derived nationally by the authors; the remainder exist in the international PISA dataset. The content of some of the measures varies across the 2012-2018 cycles. More detailed descriptions of each measure are provided in Sections 2, 3 and 4 of this report.

Table 1.4. Brief description of the survey measures included in this report

Name in datafile	Brief description	Index construction	From	2012	2015	2018	Reported in
RATCOMP1	Number of devices per student in the modal PISA grade	OECD-derived, ratio of computers available to 15-year-olds for educational purposes to the total number of students in the modal grade for 15-year olds	Principals	✓	✓	✓	Section 2
RATCOMP2	Proportion of school devices connected to the internet	OECD-derived, ratio of number of computers available to 15-year-olds for educational purposes to the number of these computers that are connected to the internet	Principals	✓	✓	✓	Section 2
ICTHOME	Index of ICT access at home	OECD-derived, based on item response theory scaling to have an OECD mean of 0 and SD of 1 (2012), count of total number of ICT items available at home (2015, 2018)	Students	✓	✓	✓	Section 2
ICTSCHOOL	Index of ICT access at school	OECD-derived, based on item response theory scaling to have an OECD mean of 0 and SD of 1 (2012), count of total number of ICT items available at school (2015, 2018)	Students	✓	✓	✓	Section 2
HOMESCH	Index of ICT use at home for schoolwork	OECD-derived, based on item response theory scaling to have an OECD mean of 0 and SD of 1	Students	✓	✓	✓	Section 2
USESCH	Index of ICT use at school	OECD-derived, based on item response theory scaling to have an OECD mean of 0 and SD of 1	Students	✓	✓	✓	Section 2
SCHCAP	Index of school's capacity to use ICT to support instruction	ERC-derived, index ranging from 0-100 based on Likert-type responses to items on school's capabilities to support teaching and learning with ICT. Scale reliabilities (Cronbach's alpha) across the 31 countries in the 2018 dataset range from .772 to .921 (median = .870)	Principals			✓	Section 3
SCHPOL	Number of ICT-related policy areas covered in school's policies	ERC-derived, based on a count of policy areas in place in the school (index range = 0 to 8 policy areas)	Principals			✓	Section 3

Table 1.4. Brief description of the survey measures included in this report (continued)

Datafile name	Brief description	Index construction	From	2012	2015	2018	Reported in
ICTCLASS	Index of use of ICT during class time for main subject areas	OECD-derived, based on item response theory scaling to have an OECD mean of 0 and SD of 1	Students			✓	Section 4
ICTOUTSIDE	Index of use of ICT outside of class time for main subject areas	OECD-derived, based on item response theory scaling to have an OECD mean of 0 and SD of 1	Students			✓	Section 4
COMPICT	Index of perceived competence in ICT usage	OECD-derived, based on item response theory scaling to have an OECD mean of 0 and SD of 1	Students			✓	Section 4
AUTICT	Index of perceived autonomy related to ICT usage	OECD-derived, based on item response theory scaling to have an OECD mean of 0 and SD of 1	Students			✓	Section 4

Analyses were conducted so as to correctly incorporate the sampling and measurement error into the estimates using IDB Analyzer (software that has been developed by the IEA[22]). School-level measures were matched to the student-level files for analysis.

This means that all of the statistics reported pertain to the numbers of students.

For the national sub-group analyses reported in Sections 3 and 4, the ERC matched national school-level data (DEIS status and school sector/gender composition) to the PISA datafile. The third variable used in the national sub-group analysis, urban/rural location of the school, is derived from the PISA school questionnaire data. For comparisons of more than two groups, we have used Bonferroni-adjusted significance levels (Dunn, 1961). This accounts for the family-wise error rate (thereby reducing the risk of inferring a significant difference between groups when in fact there is not).

Key points from Section 1

The analyses in the present report draw on information collected in PISA 2012, 2015 and 2018. While considerable change has occurred since early 2020 due to the impact of the COVID-19 pandemic, the PISA data provide baseline benchmarks against which data from future cycles can be compared. PISA, a study of the OECD, collects information from school principals and 15-year-old students via a two-hour test and questionnaire (which have been administered on computer since 2015). This report analyses broad indicators of school ICT infrastructure; students' reports of their access to and usage of ICT at school; and their access to and educational usage of ICT at home during 2012-2018. This report also examines, for 2018, principals reports of their schools' capacity to use ICT to support instruction; school policies to support ICT; students' reports of their use of ICT inside and outside of class time; and students' reports of their perceived competence and autonomy in using ICT.

The PISA data provides an excellent basis for the analyses as it provides high-quality and detailed data in three-yearly cycles, can be used to monitor trends over time, and permits robust international comparisons.

It should be noted that the data presented in this report was collected prior to the onset of the COVID-19 pandemic. Notwithstanding the significant impact and change arising from COVID-19 since early 2020, it is

22 https://www.oecd.org/pisa/data/idbanalyzerquickreproductionofthepisaresults.htm

hoped that the report will inform implementation of the new national Digital Strategy for Schools to 2027 (DoE, 2022) at post-primary level.

In the broader EU context, the Digital Education Action Plan (DEAP) 2021-2027 is an important initiative to support sustainable and effective adaptation of the education and training systems of EU member states to the digital age. The DEAP is underpinned by DigComp, a competency framework that describes digital competence in five areas (information and data literacy; communication and collaboration; digital content creation; safety; and problem-solving), and a total of 21 sub-competencies (Vuorikari et al., 2022). It is also supported by resources such as SELFIE, a free, customisable tool to help schools reflect on how they use digital technologies to support learning; and SELFIE for TEACHERS, a reflective tool for primary and post-primary teachers.

The International Computer and Information Literacy Study (ICILS) is an important means of monitoring digital competence of lower post-primary students. In the next cycle of ICILS (2023), which is conducted every five years, 30 countries (including 20 EU countries) will take part. Ireland does not currently take part in ICILS.

Recent Europe/EU-wide comparative reviews (European Commission/EACEA/Eurydice, 2019; Beblavý et al., 2019) highlight the diversity across countries/systems examined in their digital technology policies, curricula and assessments as well as challenges and potential gaps. For example, the assessment of digital competence within national assessment systems was (as at 2018/19) sparse across Europe and at upper post-primary level, the certification of digital competence at the end of schooling tended to be limited to specific cohorts of students rather than all students. Ireland is among the countries which (as at 2018/19) did not certify students' digital competence at the end of post-primary schooling, nor did it implement national assessments of digital competence at primary or post-primary levels. Calls have been made recently, at EU level, to adopt a more strategic approach at EU level, building on the DEAP 2021-2027; to create a dedicated financial instrument to enable the streamlining and sustainability of digital learning initiatives; and to increase research efforts in the area of digital learning.

Comparisons of EU countries on an index of readiness for digital lifelong learning (IRDLL) ranks Ireland 12th of the 27 countries on the overall IRDLL index, with Estonia, the Netherlands, Finland, Luxembourg, Malta, Cyprus ranked as the top six. The middling performance of Ireland on this overall index is characterised, according to Beblavý et al. (2019) by its relatively strong performance on learning participation and outcomes, this being undermined by a shortage of up-skilling initiatives and the need for a long-term vision that is sustainable. Further, Ireland's average digital skills remain comparatively low, ostensibly due to a need for more support to accompany the necessary shift in pedagogical practices; better funding and co-ordinating efforts; and targeted investment for digital skills education in schools.

A recent review of Ireland's Digital Strategy for Schools (DSS) 2015-2020 (Butler & Leahy, 2022) indicates that overall the DSS has been successful and impactful. The vision of the new DSS to 2027 (DoE, p. 11) is to *empower schools to harness the opportunities of digital transformation to build digital competence and an effective digital education ecosystem so as to develop competent, critically engaged, active learners while supporting them to reach their potential and participate fully as global citizens in a digital world.* While the new DSS makes reference to the EU's DEAP, DigComp and SELFIE, its three pillars are not exactly aligned with European developments. Rather, they build on the 2015-2021 DSS. Implementation plans for the DSS remain to be published, with the first of these to cover 2022-2024. Until implementation plans are published, the extent to which Ireland's education system may adopt (and/or adapt) DigComp remains to be seen. Butler and Leahy (2022) identify five priorities from their effectiveness review for consideration under the new Digital Strategy for Schools (DSS):

1. Development of curricular specifications to embed digital competencies development.
2. Digitally supported assessment, both of learning, and for learning (i.e., summative and formative).
3. A coherent, flexible and sustainable model of TPL for teachers.
4. Support for school leaders to incorporate DLF into school planning and improvement activities.
5. Equitable access to broadband (particularly at primary level) in conjunction with effective technical support.

The Digital Learning Framework (DLF) is regarded as a significant accomplishment of the first DSS and also features prominently in the DSS to 2027. It is a resource to guide schools on how best to effectively use digital technologies to transform their teaching, learning and assessment practices. The notion of *embedding* DT into teaching, learning and assessment is a key aim or feature of the DLF. As noted by an evaluation of the DLF, however (Cosgrove et al., 2019; Feerick et al., 2021, 2022), there is diversity in the manner in which embedding is understood in schools, as well as evidence that standards associated with levels of effective and highly effective practice need to be clarified. This observation may be linked to the fact that at present there is no national standards-based assessment of digital competence at primary or post-primary level. The DLF evaluation also provides evidence that support Butler and Leahy's (2022) priority areas 2 to 5, above.

A review of recent analyses of PISA 2018 data as they relate to ICT/DT (OECD, 2021) suggests that at post-primary level, relatively good ICT infrastructure is not matched by levels of usage or opportunity to learn digital skills at school, which fall well below OECD averages. PISA student questionnaire measures of ICT competence and ICT autonomy, though not 'traditional' educational outcomes *per se,* have been identified in recent research as being of importance in their own right due to their associations (across 42 countries) with enjoyment of science, interest in broad science topics, science self-efficacy, and epistemological beliefs about science (Areepattamannil & Santos, 2019). This report represents a move away from the more 'traditional' achievement-based outcomes and focuses solely on digital-technology related indicators.

Section 2: Comparative trends in digital technologies, 2012-2018

This section describes an analysis of data collected in PISA 2012, 2015 and 2018 relating to three areas: principals' reports of digital technology (DT) infrastructure in schools; students' reports of access to and use of DT in school; and students' reports of access to and use of DT outside of school. For each of these three indicators, we compare the data for Ireland with the corresponding averages for the participating EU and OECD countries (see Table 3.1 for the list of EU and OECD countries included in the analyses).

Trends in digital technology infrastructure in schools

Figure 2.1 shows the averages for Ireland as well as the participating EU and OECD countries for the number of devices per student in schools in 2012, 2015 and 2018, as reported by school principals. This indicator (RATCMP1 in Table 1.4) is the ratio of computers available to 15-year-olds for educational purposes to the total number of students in the modal grade for 15-year olds. Higher values on this indicator can be interpreted as more devices per student, and a value of 1 would indicate one device per student.

Note that the data shown in Figure 2.1 do not provide an indication of the quality (e.g. age, type or capacity) of devices; it is solely a count of devices.

The results indicate that there has been an increase in the number of devices per student at Irish, EU and OECD levels from 2012 to 2018. However, the magnitude of the increase in Ireland (from 0.64 to 0.74) is smaller than that for the EU average (from 0.69 to 0.85) and the OECD average (from 0.69 to 0.84). In 2012 there was no significant difference in the number of devices per student between Ireland, EU and OECD averages, but the number of devices per student in Ireland was significantly lower ($p < .05$) than the corresponding figure at the EU and OECD averages in both 2015 and 2018.

Figure 2.1. Number of devices per PISA student: Ireland, EU and OECD averages, 2012, 2015 and 2018

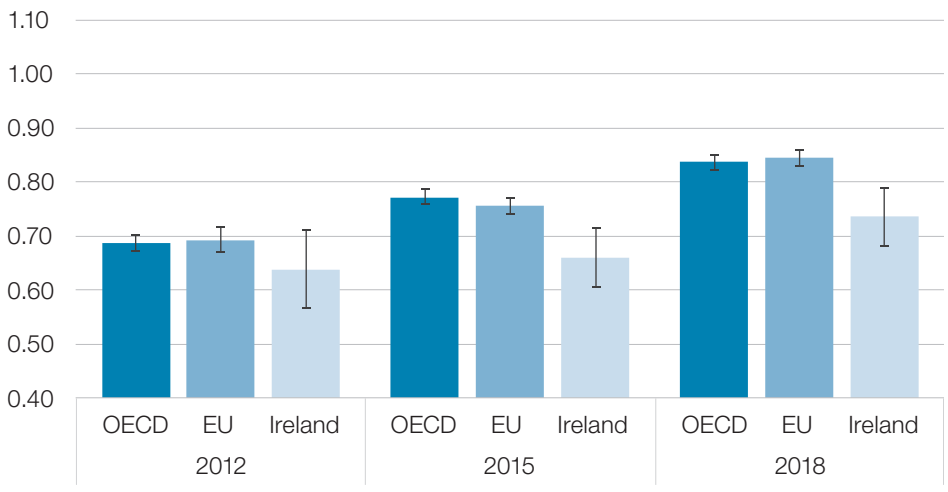
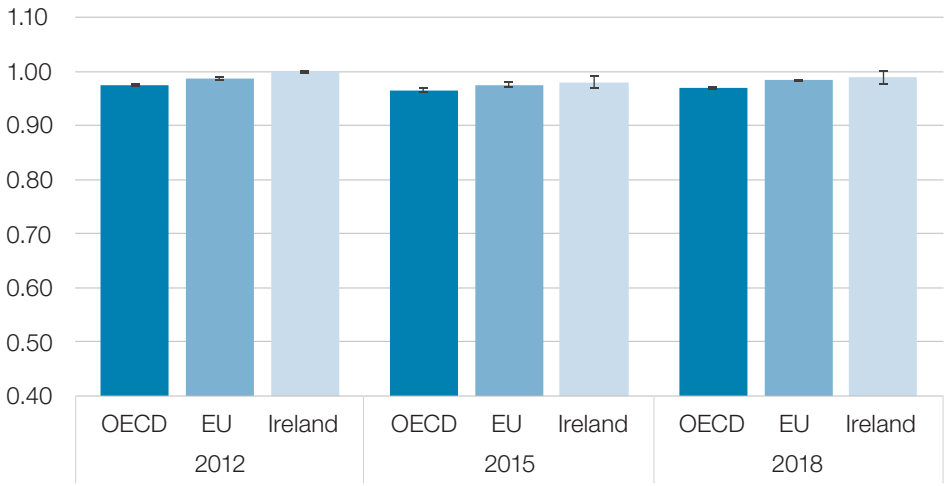


Figure 2.2 compares the rates of internet connectivity of these devices on average for Ireland, the EU and the OECD in 2012, 2015 and 2018, as reported by principals. This indicator (RATCMP2 in Table 1.4) is the ratio of number of computers available to 15-year-olds for educational purposes to the number of these computers that are connected to the internet. Higher values indicate higher rates of connectivity, with 1 indicating 100% connectivity.

Note that the data in Figure 2.2 do not indicate the speed or type of connectivity: it is an estimate of the proportion of school devices for 15-year-olds with capability of a connection.

The data indicate that internet connectivity rates are stable and close to universal across the three cycles, ranging from 0.97-0.99. There are no significant differences between Ireland, EU or OECD averages across any of the three years examined.

Figure 2.2. Rates of internet connectivity for school devices: Ireland, EU and OECD averages, 2012, 2015 and 2018



Trends in access to and usage of digital technologies in schools

Students were asked to respond to two related sets of items in all three cycles of PISA relating to access and usage of digital technologies in schools. The responses to these item sets were then summarised into two scales – ICT access in school, and ICT usage in school. Note that the 'metric' of the ICT access in school in 2012 differed to that in 2015 and 2018 (see Table 1.4 in Section 1), but this does not affect the possibility to compare the results on these scales within cycles. It should also be noted that the content and wording of these two item sets differed across cycles to reflect updates to digital technologies more generally as shown in the lists below.

ICT access in school items (ICTSCHOOL in Table 1.4) – Students asked if they have access to:

- Desktop computer;
- Portable laptop [added: or notebook in2015 and 2018];
- Tablet computer;

- Internet connection [in 2015 and 2018 this was split into two items to identify wireless connection];
- Storage space for school-related data [2015 and 2018 only];
- Printer;
- USB (memory) stick;
- Ebook reader;
- Data projector [2015 and 2018 only]; and
- Interactive whiteboard [2015 and 2018 only].

ICT usage in school items (USESCH in Table 1.4) – Students are asked the frequency of:

- Chatting on line at school;
- Using email at school;
- Browsing the internet for schoolwork;
- Downloading/uploading/browsing school's web (e.g. intranet);
- Posting my work on the school's website;
- Playing simulations at school;
- Practising and drilling, foreign language learning or mathematics;
- Doing homework on a school computer;
- Using school computers for group work and communication with other students; and
- Using learning apps or learning websites [2018 only].

Since the manner in which the access to ICT in school was constructed differed between 2012 and 2015, the results are presented as a table rather than a figure (Table 2.1). The data show that access to ICT in school in Ireland was slightly but not significantly below the EU and OECD averages in all three cycles.

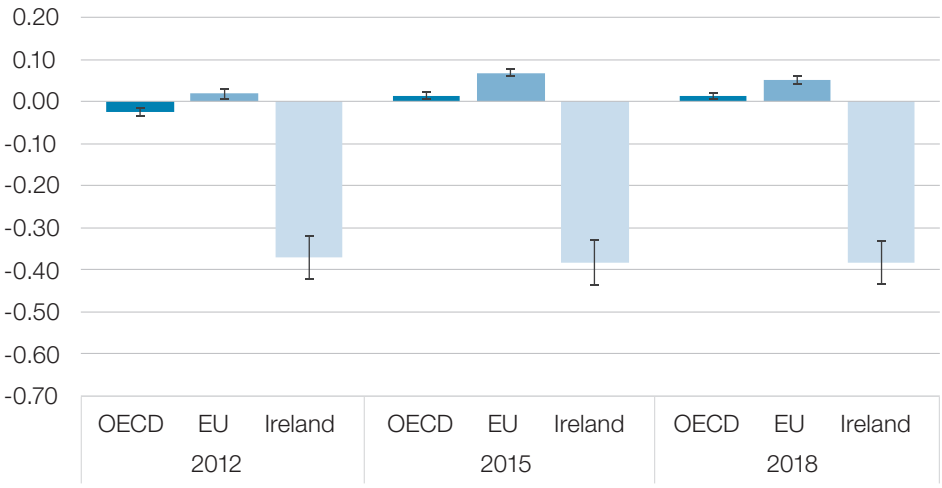
In contrast, in Figure 2.3, which shows ICT usage in school index scores, the mean score for Ireland is significantly and substantially below the EU and OECD averages across all three cycles, and the gap between the Irish and EU and OECD averages is marginally wider in 2015 and 2018 than it was in 2012.

Table 2.1. Mean scores on the access to ICT in school index: Ireland, EU and OECD averages, 2012, 2015 and 2018

ICT access in school	2012		2015		2018	
	Mean	SE	Mean	SE	Mean	SE
Ireland	-0.07	0.03	5.91	0.06	6.15	0.06
EU	-0.02	0.01	6.19	0.01	6.35	0.01
OECD	-0.02	0.01	6.09	0.01	6.28	0.01

Note: Due to a change in the approach used to construct this index between 2012 and 2015, comparisons cannot be made between the data presented for 2012 and 2015, or 2012 and 2018 (see Table 1.4)

Figure 2.3. Mean scores on the use of ICT in school index: Ireland, EU and OECD averages, 2012, 2015 and 2018



The results (Table 2.1 and Figure 2.3) paint a consistent picture across all three cycles. The Irish average on the access to ICT in school scale is similar to the respective EU and OECD averages; yet the Irish average on the usage of ICT in school scale is substantially and significantly lower than the EU and OECD averages in all three cycles. This indicates that Irish students' access to ICT in school is broadly similar to their EU and OECD counterparts on average, yet their usage of ICT during school time is considerably lower.

Trends in access to and usage of digital technologies at home

In all three cycles considered, students were asked about their access to digital technologies at home and usage of these to support their learning. The content of these indices varies somewhat across cycles (see lists below) but comparisons between Ireland and the respective EU and OECD averages *within* cycles are the focus here. The ICT access at home item set (ICTHOME) is largely unchanged, but the ICT use at home for schoolwork item set (HOMESCH) was significantly expanded in 2015 and 2018.

ICT access at home items (ICTHOME in Table 1.4) – Students asked if they have access to:

- Desktop computer;
- Portable laptop [or notebook - 2015 and 2018];
- Tablet computer;
- Internet connection;
- Video games console;
- Cell phone without internet;
- Cell phone with internet;
- Mp3/Mp4 player;
- Printer;
- USB (memory) stick; and
- Ebook reader.

ICT use at home for schoolwork (HOMESCH in Table 1.4) (* = common items across 2012, 2015 and 2018; ** common items across 2012 and 2015) – Students are asked the frequency of:

- Browsing the internet for schoolwork e.g. for preparing an essay or presentation*
- Browsing the internet to follow up lessons, e.g. for finding explanations**
- Using email for communication with other students about schoolwork*
- Using email for communication with teacher/submitting homework or other schoolwork*
- Using Social Networks for communication with other students about schoolwork**
- Using Social Networks for communication with teachers**
- Downloading from/uploading to/browsing from school website e.g. time table or course materials**
- Checking the school website for announcements e.g. absence of teachers*
- Doing homework on a computer*
- Doing homework on a mobile device**
- Downloading learning apps on a mobile device [2018 - using learning apps or websites on a computer]**
- Downloading science learning apps on a mobile device [2018 - using learning apps or websites on a mobile device]**
- Sharing school material [2012 only].

Since the construction of the access to ICT at home index changed between 2012 and 2015, results are presented as a table rather than a figure (Table 2.2). The data show that access to ICT at home in Ireland was significantly above the EU and OECD averages in all three cycles.

Table 2.2. Mean scores on the access to ICT at home index: Ireland, EU and OECD averages, 2012, 2015 and 2018

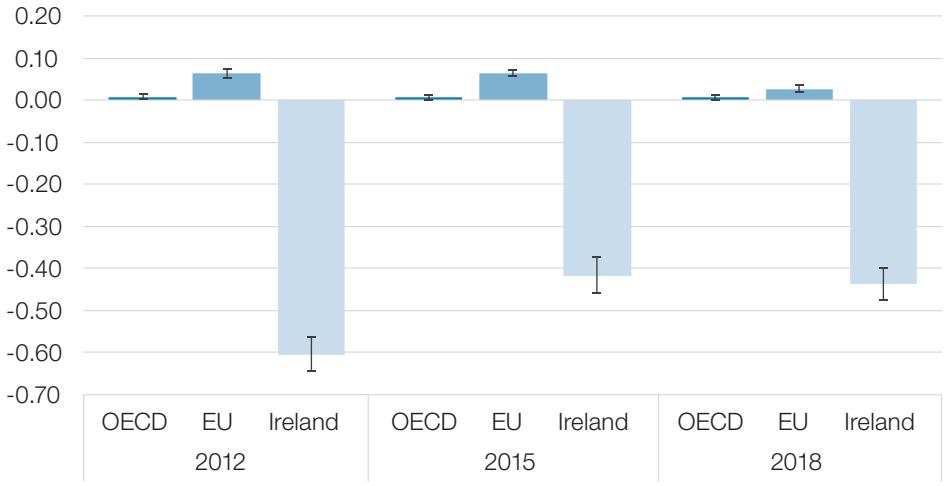
ICT access at home	2012		2015		2018	
	Mean	SE	Mean	SE	Mean	SE
Ireland	0.28	0.02	9.04	0.03	8.75	0.03
EU	0.10	0.00	8.59	0.01	8.39	0.01
OECD	-0.01	0.00	8.41	0.01	8.17	0.01

Note: Due to a change in the approach used to construct this index between 2012 and 2015, comparisons cannot be made between the data presented for 2012 and 2015, or 2012 and 2018 (see Table 1.4)

In contrast to the relatively high access to DT at home of students in Ireland relative to the EU and OECD averages, student usage of DT at home for educational purposes is substantially and significantly lower in Ireland than on average across the EU and OECD in all three cycles (Figure 2.4).

The marked contrast in the findings in Table 2.2 and Figure 2.4 indicate that while students in Ireland have significantly higher rates of access to DT at home than their EU and OECD peers in 2012, 2015 and 2018, their usage of DT at home for educational purposes is consistently, substantially and statistically significantly lower than the EU and OECD averages, and the magnitude of this difference was largest in 2012. This indicates that the reasons for the low rates of usage by students in Ireland of digital technologies to support their learning outside of school time are not due to low rates of access to digital technologies.

Figure 2.4. Mean scores on the use of ICT at home for educational purposes index: Ireland, EU and OECD averages, 2012, 2015 and 2018



Key points from Section 2

PISA 2012, 2015 and 2018 datasets allow comparisons on indicators of school ICT infrastructure, student access and usage of DT at school, and access to and usage of DT at home for educational purposes. In all, data for 31-32 OECD countries and 20-22 EU countries were available for comparison across the three cycles.

Internet connectivity for school devices were almost universal across Ireland, EU and OECD in 2012, 2015 and 2018. This is a broad indicator, and does not provide information on quality or speed of connection. Over the same time period, there has been an increase in the number of computing devices per student in schools in Ireland, the EU and the OECD. However, the increase in devices per student is smaller in Ireland (from 0.64 to 0.74) than on average across the EU (from 0.69 to 0.85) or the OECD (from 0.69 to 0.84). This is also a broad indicator. It does not capture information on the quality of devices (such as age, processing speed, and so on).

In all three cycles (2012, 2015 and 2018) students in Ireland reported similar rates of access to ICT in school compared to the EU and OECD averages. However, students' ICT usage during school time in Ireland was considerably and significantly lower than on average across the EU and OECD across all three cycles examined.

Students' access to digital technologies at home was significantly higher in Ireland than on average across the EU and the OECD for each of 2012, 2015 and 2018. Despite comparatively high rates of home access, though, the use of digital technologies outside of school to support learning among students in Ireland was substantially and significantly lower than the EU and OECD averages in all three cycles. This mirrors the comparatively low rates of students' usage of ICT during school time.

Section 3: Schools' digital technologies: international and national comparisons, 2018

This section provides an analysis of two school-level indices derived from PISA 2018: principals' reports on *school capacity to use digital technologies (DT) to support teaching and learning* and *school DT-related policies*. Responses on individual items of the indices are provided along with national and international means. Subgroup comparisons within Ireland are also described. Key points are outlined at the end of this chapter.

School-level data were matched to the student-level files for analysis (see Section 1). This means that all of the statistics reported in Section 3 pertain to numbers of students, not numbers of schools.

Both of the indices reported in Section 3 were created by the authors specifically for this report (see Section 1, Table 1.4), and so do not feature in any existing national or international publications.

Schools' capacity to use digital technology to support teaching and learning

Principals were asked to respond to 11 items in the question set designed to assess schools' capacity to use DT to support teaching and learning (see also SCHCAP in Section 1, Table 1.4), with four response options ranging from Strongly disagree to Strongly agree. For analysis purposes, the items were combined into an index whose scores range from 0-100.

As displayed in Figure 3.1, the mean score for Ireland on the *school capacity to use DT* index (with higher scores indicating more capacity) was significantly lower than the mean score for both the EU, and the OECD (Ireland's mean score was 49.5, compared with EU and OECD mean score of 57.2 and 57.6, respectively; $p < .025$). This indicates that the capacity of schools in Ireland to support and enhance teaching and learning using digital technology was substantially and significantly below that of schools in the EU and OECD, on average.

Figure 3.1. Means and 95% confidence intervals for the School capacity using DT index: Ireland, EU, and OECD averages, 2018

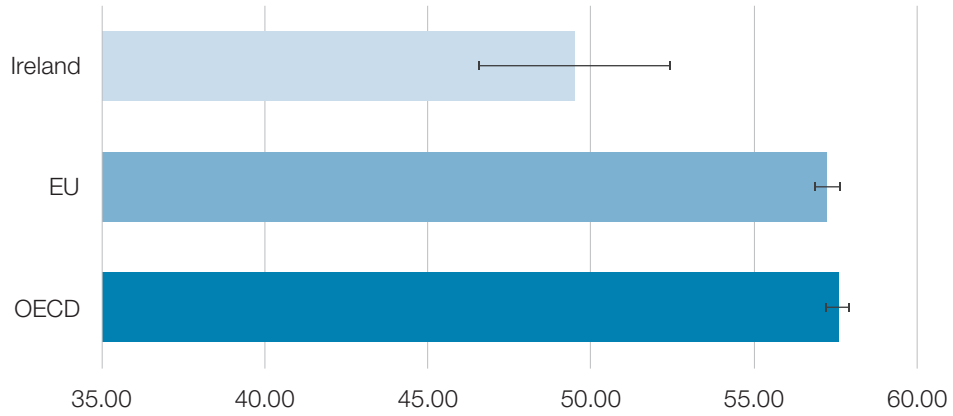


Table A3.1 in the Appendix shows the means of the countries contributing to this index. Particularly high scores (ranging from 65.5 to 72.5, all well above the average index score for Ireland of 49.5) were recorded for Switzerland, the United States, Turkey, Norway, Slovenia, Austria, Denmark, Lithuania, and Sweden.

Table 3.1 displays the frequencies for Ireland of principals' responses on individual items comprising the index. Response categories to these items were on a four-point Likert scale, ranging from Strongly disagree to Strongly agree.

There are variations in the percentages agreeing/disagreeing with individual statements, which is indicative of an unevenness in DT capacity components across schools. Over 70% of students were in schools where principals agreed or strongly agreed that the school's internet bandwidth or speed, device power and available software were sufficient. In contrast, only 21% of students were in schools where principals agreed/strongly agreed that the school had adequate technical support staff, and 36% agreed/strongly agreed that teachers had sufficient incentives to integrate DT into teaching and learning.

Agreement levels with the remaining six items ranged from 45% to 57%. These six items, in descending order, cover number of digital devices connected to the internet; sufficient time for teachers to prepare lessons integrating digital devices; level of technical and pedagogical skills of teachers; effective professional resources for teachers; number of digital devices for instruction; and availability of an effective online learning support platform.

The very low level of agreement with the statement on technical support staff is of concern since adequate technical support is arguably a foundation for the effective use and maintenance of the available DT infrastructure in schools.

Table 3.1. Percentages of students whose principals indicated agreement or disagreement on individual items of the schools' capacity to use digital technology to support teaching and learning index: Ireland, 2018

Item	Strongly disagree	Disagree	Agree	Strongly agree
The school's internet bandwidth or speed is sufficient	6.4	17.7	49.5	26.4
The number of digital devices connected to the internet is sufficient	15.4	28.1	41.2	15.3
Digital devices at the school are sufficiently powerful in terms of computing capacity	6.6	20.2	59.5	13.7
The availability of adequate software is sufficient	4.4	23.7	59.4	12.5
The number of digital devices for instruction is sufficient	13.2	41.5	34.2	11.1
Teachers have sufficient time to prepare lessons integrating digital devices	13.3	35.9	43.6	7.2
Teachers are provided with incentives to integrate digital devices in their teaching	19.2	44.9	29.5	6.3
An effective online learning support platform is available	7.1	47.7	40.2	5.0
Effective professional resources for teachers to learn how to use DT is available	8.6	44.5	42.3	4.6
The school has sufficient qualified technical assistant staff	46.2	33.2	16.6	4.0
Teachers have the necessary technical and pedagogical skills to integrate digital devices in instruction	10.3	40.7	45.9	3.1

Schools' digital technology related policies

Principals were asked to respond to eight statements, with a yes/no format, that were used to form the *school DT related policies* index (SCHPOL in Section 1, Table 1.4). Scores on this index range from 0 to 8 and can be interpreted as the number or count of DT-related policy areas covered in schools' policies and processes. As displayed in Figure 3.2, the mean score for Ireland on the *School DT related policies* index was significantly higher than the mean score for both the EU, and the OECD (Ireland's mean score 4.5, compared with EU and OECD mean score of 3.9 and 4.1, respectively; $p < .025$). This finding indicates that schools in Ireland had more policies or processes in the area of DT compared with their counterparts in the EU and OECD.

Figure 3.2. Means and 95% confidence intervals for the school digital technology related policies index: Ireland, EU, and OECD averages, 2018

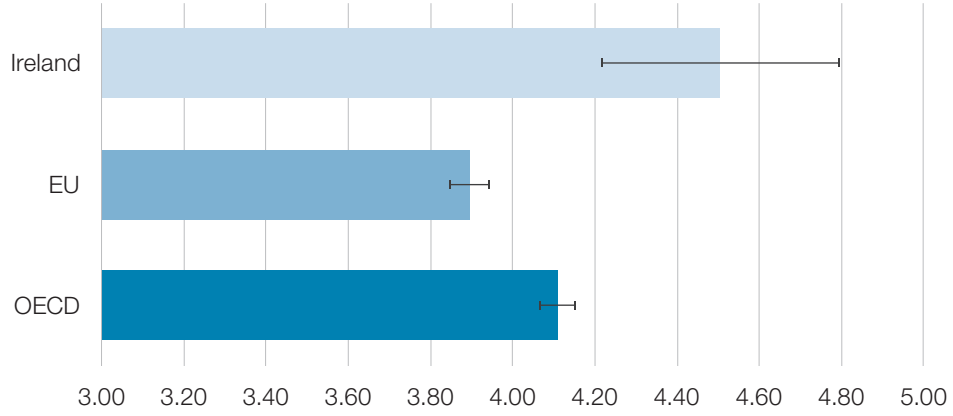


Table A3.1 in the Appendix shows the means of the countries contributing to this index. Particularly high mean scores (with countries on average having about 5 or 6 of 8 policies in place, which is above the Irish average index score of 4.5) were recorded for the Netherlands, the United Kingdom, Norway, the United States, Australia, and New Zealand.

Table 3.2 displays the frequencies of responses on individual items of the *school DT related policies* index in Ireland. This gives an indication of the areas most and least frequently covered in schools' policies and procedures. The vast majority of students in Ireland (91%) were in schools whose principal indicated that they had their own written statement about the use of digital devices. The majority of schools also had policies on the following: regular discussions with teaching staff about the use of digital devices for pedagogical purposes (73% of students were in schools whose principals reported this); a specific programme to prepare students for responsible internet behaviour (70%); and a specific policy about using Social Networks (e.g. Facebook) in teaching and learning (54%).

However, approximately three-fifths of students were in schools whose principals indicated that they did not have policies on the following: a programme to use digital devices for teaching and learning in specific subjects (62%); a specific programme to promote collaboration on the use of digital devices among teachers (61%); and scheduled time for teachers to meet to share, evaluate or develop instructional materials and approaches that employ DT (57%).

These findings indicate that while many schools in Ireland had policies relating to general procedures and safe use of DT, there was a comparatively lower emphasis on policies and procedures designed to strategically enhance the use of DT, such as policies or processes on collaboration, specific subjects, and dedicated time for teachers.

Table 3.2. Percentages of students whose principals indicated agreement or disagreement on individual items of the school digital technology related policies index: Ireland, 2018

Item	Yes	No
Its own written statement about the use of digital devices	91.3	8.7
Regular discussions with teaching staff about the use of digital devices for pedagogical purposes	73.0	27.0
A specific programme to prepare students for responsible internet behaviour	69.5	30.5
A specific policy about using Social Networks (e.g., Facebook) in teaching and learning	53.7	46.3
Its own written statement specifically about the use of digital devices for pedagogical purposes	45.7	54.3
Scheduled time for teachers to meet to share, evaluate or develop instructional materials and approaches that employ digital technologies	42.9	57.1
A specific programme to promote collaboration on the use of digital devices among teachers	39.1	60.9
A programme to use digital devices for teaching and learning in specific subjects	38.3	61.7

Variations in schools' capacity to use digital technologies to support teaching and learning and policies related to digital technologies in Ireland by school type

Table 3.3 displays the mean scores on the school capacity to use DT index by DEIS status, school sector/gender composition, and urban/rural location. Schools' capacity to use DT did not vary significantly by sector/gender composition or by urban/rural location, but the mean score associated with students in DEIS schools (43) was significantly and substantially lower than the non-DEIS mean (52). This finding indicates that non-DEIS schools' capacity to enhance learning and teaching using digital technologies was significantly higher than that of DEIS schools in Ireland.

Table 3.3. Means and standard errors on the school capacity to use digital technology to support teaching and learning index: Ireland, 2018 - comparisons by school DEIS status, sector/gender composition, and urban/rural location

Group	Mean	SE	Significance
Ireland - All	49.50	1.51	
DEIS status			
DEIS	42.65	2.68	
Non-DEIS	51.50	1.71	*
Sector/gender			
Girls' Secondary	50.74	2.60	
Boys' Secondary	55.04	4.29	NS
Mixed Secondary	44.23	2.94	NS
Community/Comprehensive	46.64	4.19	NS
Vocational (ETB)	50.16	2.91	NS
Urban/rural location			
Rural	46.09	3.77	
Town	50.41	1.78	NS
City	49.56	2.94	NS

Note: Grey shading indicates reference group. NS not significantly different, * significant p < .05, ** significant p < .01.

Table 3.4 displays the mean scores on the school DT related policies index by DEIS status, sector/gender composition, and urban/rural location. There were no significant differences in the mean scores across these subgroups on this index.

Table 3.4. Means and standard errors on the school digital technology related policies index: Ireland, 2018 - comparisons by school DEIS status, sector/gender composition, and urban/rural location

Group	Mean	SE	Significance
Ireland - All	4.50	0.15	
DEIS status			
DEIS	4.70	0.26	
Non-DEIS	4.44	0.17	NS
Sector/gender			
Girls' Secondary	4.25	0.38	
Boys' Secondary	4.27	0.29	NS
Mixed Secondary	4.31	0.34	NS
Community/Comprehensive	4.11	0.31	NS
Vocational (ETB)	5.14	0.29	NS
Urban/rural location			
Rural	4.88	0.25	
Town	4.42	0.18	NS
City	4.36	0.33	NS

Note: Grey shading indicates reference group. NS not significantly different, * significant p < .05, ** significant p < .01.

Key points from Section 3

In 2018, Ireland's mean score on an index of the school's capacity to use DT to support teaching and learning (as reported by principals) was significantly lower than the mean for both the EU and the OECD. An analysis of the responses to the eleven items that comprise this index reveals variations in the extent to which students are in schools where principals agree that various components of DT are adequate. In particular, reported levels of qualified technical support staff were very low, with only 21% of students being in schools where this was perceived to be adequate. This is of concern since it can be reasonably assumed that adequate technical maintenance and support is a precursor to the effective use of available DT infrastructure for teaching, learning and assessment.

Non-DEIS schools had a significantly higher mean score than DEIS schools on the school capacity to use DT index, indicating that non-DEIS schools' capacity to enhance learning and teaching using digital devices was significantly higher than that of DEIS schools. Mean scores on this index did not vary significantly by urban/rural location or sector/gender composition of the school.

In 2018, it was observed that, of a total of eight DT-related policy areas, on average, students in Ireland were in schools with 4.5 policies in place. This is slightly, albeit statistically significantly higher than both the EU and OECD averages (approximately 4 for both). An analysis of the eight individual policy areas showed that while many Irish schools had policies relating to general procedures and safe use of DT, there was a lower emphasis on policies and procedures designed to strategically enhance the use of DT for teaching, learning and assessment. There were no statistically significant differences in the school DT related policies index within Ireland by DEIS status, sector/gender composition or urban/rural location.

Several countries recorded higher mean scores than Ireland on both of the indices examined in this section. High levels of schools' capacity to use DT to support teaching and learning were recorded for Switzerland, the United States, Turkey, Norway, Slovenia, Austria, Denmark, Lithuania, and Sweden; while high numbers of school DT related policies were found in the Netherlands, the United Kingdom, Norway, United States, Australia, and New Zealand. This confirms that, comparatively speaking, Ireland could improve in both school's capacity to use DT and in DT policy implementation. Regarding schools' capacity to use DT to support teaching and learning, the results indicate that improvements in schools' technical support and maintenance should be prioritised. Regarding schools' DT related policies, the analysis of individual items suggest that improvements could be made in the ways schools' policies relate to the strategic use of DT to enhance teaching and learning.

Section 4: Student digital technology indicators: International and national comparisons, 2018

This section provides an analysis of four student indices which are available in the international PISA 2018 database: *subject-related use of digital technologies (DT) during class time, subject-related use of DT outside of class time, perceived competence in using DT, and perceived autonomy in using DT.* Indices measuring use of DT during and outside class time are based on students' reports of how often such technologies are used and do not capture how effective or productive this use is. Furthermore, *perceived competence* and *perceived autonomy in using DT* are measured through students' own evaluations of how comfortable they are using DT and the extent to which they feel they can engage with DT independently. The national and international means (EU and OECD) of these measures are described, and individual item responses for students in Ireland provided. Subgroup comparisons within Ireland are also described. Key points are summarised in the final part of this section.

Subject-related use of digital technologies during class time

Students were asked how much time per week they used digital technologies during class time for various subject areas. The overall average score for students in Ireland on the subject-related use of DT during class time index was -0.37, which is substantially and significantly lower than both the OECD and EU averages (0.00 and -0.05, respectively; Figure 4.1). This score puts Ireland at 28th place out of 31 countries on this scale (see Table A4.1 in the Appendix). In contrast, particularly high mean scores (of 0.35 or higher) were found for the United States, Iceland, New Zealand, Australia, Sweden, and Denmark.

Figure 4.1. Means and standard errors on the subject-related use of DT during class scale: Ireland, EU and OECD averages, 2018

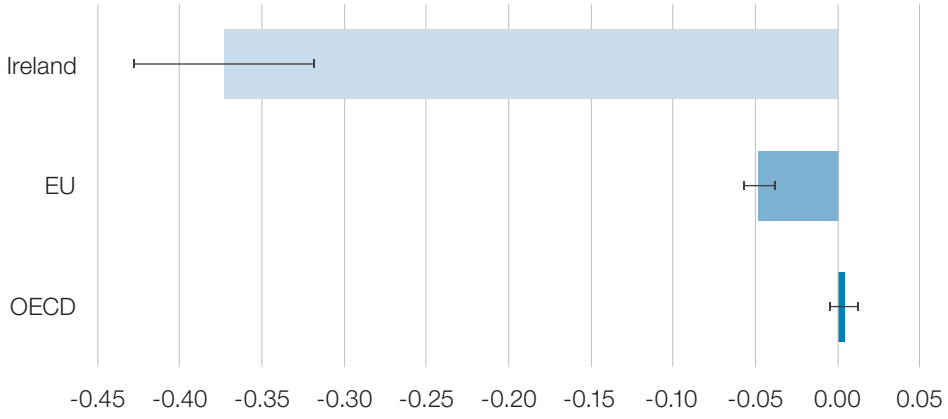


Table 4.1 shows the responses of students in Ireland to the individual items that make up the subject related use of DT during class time index. The pattern of responses shows that the mean score for Ireland (Figure 4.1) is very low due to the fact that between 62% and 70% reported *never* using DT during class time for English, mathematics, science, foreign languages and/or social sciences subjects.

Table 4.1. Frequencies of responses on individual items of the subject-related use of DT during class time index: Ireland, 2018

Subject	No time	1-30 minutes a week	31-60 minutes a week	More than 60 minutes a week	I do not study this subject
English	66.6	19.6	7.9	5.6	0.3
Mathematics	69.7	15.7	8.1	6.2	0.4
Science (Junior Cert science or Leaving Cert science subjects	61.6	20.5	9.3	5.9	2.8
Foreign language	61.7	19.7	9.1	5.3	4.2
Social sciences (e.g. CSPE, Politics and Society, SPHE, ESS, Social Education, Home Economics)	64.8	18.4	7.4	3.3	6.0

Table 4.2 compares the mean scores on the subject-related use of DT during class time index across key school (i.e., school DEIS status, sector/gender composition, urban/rural location) and student characteristics (student gender, whether in junior or senior cycle, immigration status, and socio-economic or ESCS[23] quartile).

Relative to girls' secondary schools, subject-related use of DT was, on average, significantly lower in boys' secondary and community/comprehensive schools. On the other hand, mean scores on this index did not vary by DEIS status or urban/rural location.

Girls reported slightly though significantly higher frequencies of subject related use of DT in class time than boys, and frequency of using DT during class time was slightly but significantly higher among senior cycle students compared to those at junior cycle level. Students in the lower two ESCS quartiles had significantly lower mean scores on this index than students in the upper two ESCS quartiles, meaning that more socio-economically advantaged students used DT during class time more often than their less advantaged peers. However, the mean score of socio-economically advantaged students in Ireland on this index were well below the respective OECD and EU averages. In Ireland, there were no significant differences between native students and their first- and second-generation peers on this index.

The terms 'native', 'first generation' and 'second generation' are those used by the OECD.

Native students are defined as those with at least one parent born in the country; first-generation students are those born outside the country of assessment and whose parents were also born in another country; and second-generation students are those born in the country of assessment but whose parent(s) were born in another country.

For the sake of clarity, the same terms are used in this report.

23 In PISA, student socio-economic context is based on a combined index of Economic, Social and Cultural Status (ESCS). See OECD (2020, Chapter 16) for technical information on the construction and validation of this measure.

Table 4.2. Means and standard errors on the subject-related use of DT during class index: Ireland, 2018 - comparisons by school DEIS status, sector/gender composition, and urban/rural location; and by student gender, junior/senior cycle, immigrant status, and ESCS quartile

Group	Mean	SE	Significance
Ireland – All	-0.37	0.03	
DEIS status			
DEIS	-0.38	0.07	
Non-DEIS	-0.37	0.03	NS
Sector/gender			
Girl' Secondary	-0.29	0.05	
Boys' Secondary	-0.51	0.04	**
Mixed Secondary	-0.27	0.08	NS
Community/Comprehensive	-0.49	0.04	**
Vocational (ETB)	-0.35	0.07	NS
Urban/rural location			
Rural	-0.42	0.08	
Town	-0.34	0.04	NS
City	-0.40	0.03	NS
Student gender			
Male	-0.43	0.03	
Female	-0.32	0.03	**
Junior/senior cycle			
Junior cycle	-0.43	0.03	
Senior cycle	-0.28	0.03	**
Immigration status			
Native	-0.38	0.03	
Second generation	-0.40	0.05	NS
First generation	-0.32	0.05	NS
ESCS quartile			
1 (Lowest)	-0.48	0.03	
2 (Second lowest)	-0.41	0.03	NS
3 (Second highest)	-0.34	0.03	**
4 (Highest)	-0.26	0.04	**

Note: Grey shading indicates reference group. NS not significantly different, * significant p < .05, ** significant p < .01.

Subject-related use of digital technologies outside of class time

Students were also asked how much time per week they used digital technologies outside of class time for various subject areas. The overall average score for students in Ireland on the subject-related use of DT outside class time index was -0.30 which is again substantially and significantly lower than both the OECD and EU averages (0.01 and 0.02, respectively; Figure 4.2). As with the subject-related use of DT during class time, the outside of class time index score puts Ireland at 28th place out of 31 countries on this scale (see Table A4.1 in the Appendix). In contrast, very high mean scores (of 0.30 or higher) were found for the United States, New Zealand, the United Kingdom, Sweden, Australia, and Denmark.

The country-level correlation between the subject-related use of DT inside and outside of class time is strong and positive, at .72. This indicates that countries with higher frequencies of subject-related usage in class also tend to have higher frequencies of subject-related usage outside of class.

Figure 4.2. Means and standard errors on the subject-related use of DT outside of class index: Ireland, EU and OECD averages, 2018

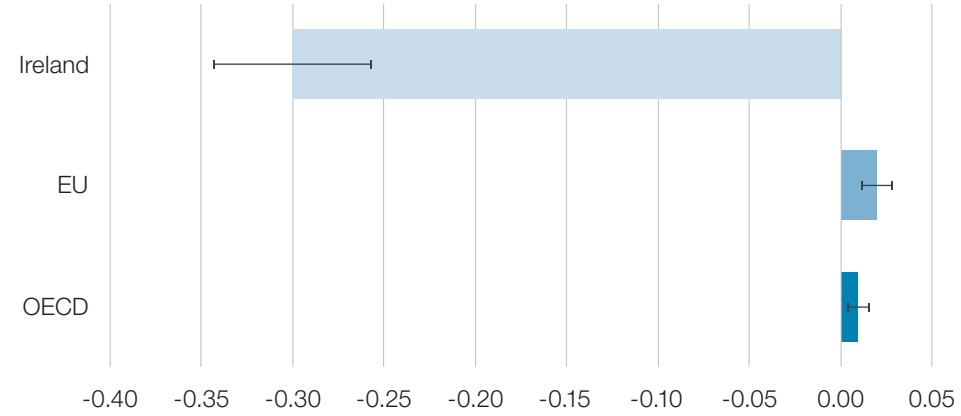


Table 4.3 shows the responses of students in Ireland to the individual items of the subject-related use of DT outside of class time index. The pattern of responses indicates that between approximately 43% and 66% of students reported *never* using DT outside of class time for English, mathematics, science, foreign languages and/or social sciences subjects.

Comparing Tables 4.1 and 4.3, it can be seen that the frequency of use outside of class time is generally higher than use during class. Also, frequency of using DT is particularly low for mathematics, both inside and outside of class. Reported use of DT for foreign language learning outside of class time (57% reported spending some time doing so, Table 4.3) was considerably higher than for inside of class time (38% reported spending some time doing so, Table 4.1).

Table 4.3. Frequencies of responses on individual items of the subject-related use of digital technologies outside of class time index: Ireland, 2018

Subject	No time	1-30 minutes a week	31-60 minutes a week	More than 60 minutes a week	I do not study this subject
English	49.4	35.9	9.6	4.6	0.4
Mathematics	61.1	25.6	7.9	5.0	0.4
Science (Junior Cert science or Leaving Cert science subjects	51.4	30.8	10.2	4.4	3.2
Foreign language	42.8	34.9	12.4	5.5	4.5
Social sciences (e.g. CSPE, Politics and Society, SPHE, ESS, Social Education, Home Economics)	66.4	18.3	5.1	3.2	6.8

Table 4.4 compares the mean scores on the subject-related use of DT outside of class time index across key school (i.e., school DEIS status, sector/gender composition, urban/rural location) and student characteristics (student gender, whether in junior or senior cycle, immigration status, and socio-economic or ESCS quartile).

Table 4.4. Means and standard errors on the subject-related use of DT outside of class time index: Ireland, 2018 - comparisons by school DEIS status, sector/gender composition, and urban/rural location; and by student gender, junior/senior cycle, immigrant status, and ESCS quartile

Group	Mean	SE	Significance
Ireland - All	-0.30	0.02	
DEIS status			
DEIS	-0.31	0.05	
Non-DEIS	-0.29	0.02	NS
Sector/gender			
Girls' Secondary	-0.25	0.04	
Boys' Secondary	-0.41	0.03	**
Mixed Secondary	-0.23	0.06	NS
Community/Comprehensive	-0.36	0.05	NS
Vocational (ETB)	-0.27	0.05	NS
Urban/rural location			
Rural	-0.31	0.07	
Town	-0.28	0.03	NS
City	-0.32	0.03	NS
Student gender			
Male	-0.32	0.03	
Female	-0.28	0.03	NS
Junior/senior cycle			
Junior cycle	-0.25	0.03	
Senior cycle	-0.37	0.03	**
Immigration status			
Native	-0.33	0.02	
Second generation	-0.19	0.06	*
First generation	-0.17	0.05	**
ESCS quartile			
1 (Lowest)	-0.35	0.03	
2 (Second lowest)	-0.33	0.03	NS
3 (Second highest)	-0.30	0.03	NS
4 (Highest)	-0.20	0.04	**

Note: Grey shading indicates reference group. NS not significantly different, * significant p < .05, ** significant p < .01.

Relative to students in girls' secondary schools, subject-related use of DT outside of class time was significantly lower among students in boys' secondary schools. On the other hand, mean scores on this index did not vary by DEIS status or urban/rural location.

Frequency of subject related use of DT outside of class time was slightly but significantly lower among senior cycle students compared with those at junior cycle (which is the opposite of what was found for subject-related use of DT during class time; see Table 4.2). Students in the uppermost ESCS quartile had a significantly higher mean score on this index than students in the lowest ESCS quartile, meaning that the most socio-economically advantaged students used DT outside class time more often than their less advantaged peers. Interestingly, use of DT outside of class time for subject learning was significantly lower for native students compared to first- and second-generation students, while there was no difference in the frequency of subject-related DT usage outside of class time between boys and girls.

Perceived competence in using digital technologies

Students were asked the extent to which they agreed or disagreed with five statements designed to measure their perceived competence in using digital technologies. The overall average score for students in Ireland on the perceived competence in using DT index was 0.18, which is significantly higher than both the OECD and EU averages (Figure 4.3). This score puts Ireland at 6th place out of 32 countries on this scale and 5th across the EU countries with available data (Table A4.2, Appendix). Ireland's mean score was similar to that of both Australia and New Zealand, while Sweden and the UK recorded the highest mean scores across all countries on this index.

Figure 4.3. Means and standard errors on the perceived competence in using DT index: Ireland, EU and OECD averages, 2018

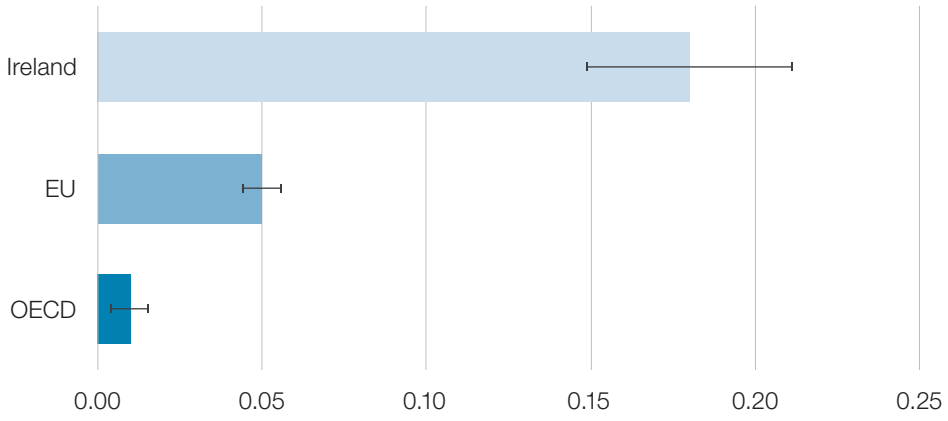


Table 4.5 shows the responses of students in Ireland to the individual items that make up the perceived competence in using DT index. Reflecting the overall high mean score on this scale shown in Figure 4.2, a large majority of students in Ireland (between approximately 69%-95%) agreed or strongly agreed with all five DT competence-related statements. Students most strongly agreed with the statement 'I feel comfortable using my digital devices at home' while the rate of agreement was lowest (though still quite high, at 69%) for the statement 'I feel comfortable using digital devices that I am less familiar with'.

Table 4.5. Percentages of students who indicated agreement or disagreement on the individual items of the perceived competence in using DT index: Ireland, 2018

Item	Strongly disagree	Disagree	Agree	Strongly Agree
I feel comfortable using digital devices that I am less familiar with.	4.7	26.8	53.8	14.8
If my friends and relatives want to buy new digital devices or applications, I can give them advice.	2.9	17.3	58.3	21.5
I feel comfortable using my digital devices at home.	1.8	3.2	54.5	40.5
When I come across problems with digital devices, I think I can solve them.	2.3	12.5	59.5	25.7
If my friends and relatives have a problem with digital devices, I can help them.	3.3	17.1	57.7	21.9

Table 4.6 compares the mean scores on the perceived competence in using DT index across key school (i.e., school DEIS status, sector/gender composition, urban/rural location) and student characteristics (i.e., student gender, whether in junior or senior cycle, immigration status, and socio-economic or ESCS quartile).

On average, perceived DT competence scores do not vary across school DEIS status, sector/gender composition, or urban/rural location. However, the mean score on the perceived competence in using DT scale was significantly lower for girls than for boys, and for students in senior cycle when compared to those in junior cycle. Native students had a significantly lower mean score on the perceived competence in using DT scale when compared to their first- and second-generation counterparts. The pattern of competence in using DT scores across ESCS (i.e., a proxy for socio-economic status) quartile is uneven; nonetheless, students in the highest (most advantaged) quartile had the highest mean perceived competence in using DT score across the four ESCS groups.

Table 4.6. Means and standard errors on the perceived competence in using DT index: Ireland, 2018 - comparisons by school DEIS status, sector/gender composition, and urban/rural location; and by student gender, junior/senior cycle, immigrant status, and ESCS quartile

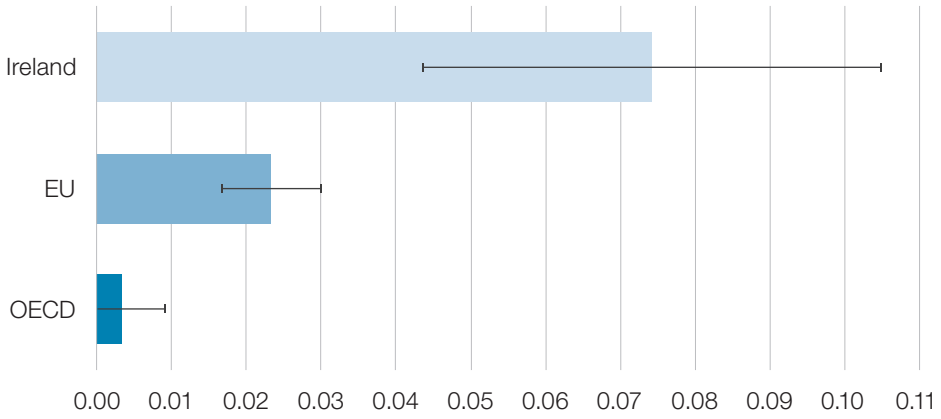
Group	Mean	SE	Significance*
Ireland – All	0.18	0.02	
DEIS status			
DEIS	0.19	0.03	
Non-DEIS	0.16	0.02	NS
Sector/gender			
Girls' Secondary	0.18	0.03	
Boys' Secondary	0.22	0.04	NS
Mixed Secondary	0.24	0.04	NS
Community/Comprehensive	0.18	0.03	NS
Vocational (ETB)	0.13	0.03	NS
Urban/rural location			
Rural	0.12	0.04	
Town	0.19	0.02	NS
City	0.21	0.03	NS
Student gender			
Male	0.25	0.02	
Female	0.12	0.02	**
Junior/senior cycle			
Junior cycle	0.21	0.02	
Senior cycle	0.13	0.02	**
Immigration status			
Native	0.15	0.02	
Second generation	0.31	0.05	**
First generation	0.31	0.04	**
ESCS quartile			
1 (Lowest)	0.08	0.03	
2 (Second lowest)	0.21	0.03	**
3 (Second highest)	0.15	0.03	NS
4 (Highest)	0.29	0.02	**

Note: Grey shading indicates reference group. NS not significantly different, * significant p < .05, ** significant p < .01.

Perceived autonomy in using digital technologies

Students were asked the extent to which they agreed or disagreed with five statements designed to measure their perceived autonomy in using DT. The overall average score for Irish students on the perceived autonomy in using use of DT during class time index was 0.07, which is just slightly but nonetheless statistically significantly higher than both the OECD and EU averages (Figure 4.4). This score puts Ireland at 6th place out of 31 countries on this scale and 5th across the EU countries with available data (Table A4.2, Appendix). Ireland's mean score was similar to that of Denmark, Luxembourg, Spain and the United Kingdom while Iceland, France and Germany recorded the highest mean score across all countries on this index.

Figure 4.4. Means and standard errors on the perceived autonomy in using DT index: Ireland, EU and OECD averages, 2018



The country-level correlation between the perceived DT competence and perceived DT autonomy indices is moderately strong and positive, at .53. This shows that countries whose students reported having high levels of competence in using DT also tended to perceived themselves as having high levels of autonomy in using DT.

Table 4.7 shows the responses of students in Ireland to the individual items that make up the perceived autonomy in using DT index. A majority of students in Ireland (between 65% and 89%) agreed or strongly agreed with all five statements. Students most strongly agreed with the statement 'I use digital devices as I want to use them', while 65% agreed or strongly agreed with the statement 'If I need new software, I install it by myself'.

Table 4.7. Percentages of students who indicated their agreement or disagreement on individual items of the perceived autonomy in using DT index: Ireland, 2018

Item	Strongly Disagree	Disagree	Agree	Strongly Agree
If I need new software, I install it by myself	7.7	27.3	46.4	18.5
I read information about digital devices to be independent	5.2	28.4	53.4	13.1
I use digital devices as I want to use them	2.2	9.1	64.1	24.6
If I have a problem with digital devices I start to solve it on my own	3.3	14.6	60.9	21.1
If I need a new application, I choose it by myself	2.8	14.1	58.2	24.9

Table 4.8 compares the mean scores on the perceived autonomy in using DT index across key school (i.e., school DEIS status, sector/gender composition, urban/rural location) and student characteristics (i.e., student gender, whether in junior or senior cycle, immigration status, and socio-economic or ESCS quartile).

Table 4.8. Means and standard errors on the perceived autonomy in using DT index: Ireland, 2018 - comparisons by school DEIS status, sector/gender composition, and urban/rural location; and by student gender, junior/senior cycle, immigrant status, and ESCS quartile

Group	Mean	SE	Significance*
Ireland – All	0.07	0.02	
DEIS status			
DEIS	0.03	0.03	
Non-DEIS	0.09	0.02	NS
Sector/gender			
Girls' Secondary	-0.04	0.03	
Boys' Secondary	0.21	0.04	**
Mixed Secondary	0.16	0.05	**
Community/Comprehensive	0.04	0.03	NS
Vocational (ETB)	0.05	0.03	NS
Urban/rural location			
Rural	0.02	0.04	
Town	0.10	0.02	NS
City	0.07	0.03	NS
Student gender			
Male	0.23	0.02	
Female	-0.09	0.02	**
Junior/senior cycle			
Junior cycle	0.10	0.02	
Senior cycle	0.03	0.02	**
Immigration status			
Native	0.03	0.03	
Second generation	0.30	0.05	**
First generation	0.26	0.05	**
ESCS quartile			
1 (Lowest)	-0.05	0.03	
2 (Second lowest)	0.09	0.03	**
3 (Second highest)	0.06	0.03	**
4 (Highest)	0.19	0.03	**

Grey shading indicates reference group. NS not significantly different, * significant p < .05, ** significant p < .01.

Mean scores on the perceived autonomy in using DT scale do not vary significantly across schools' DEIS status or urban/rural location. However, the mean perceived autonomy in using DT score of students in girls' secondary schools is significantly lower than that of students in all boys' secondary and mixed secondary schools. This school-level difference is explained, at least in part, by the fact that the mean score on the DT autonomy index for girls was about a third of a standard deviation (and significantly) below that of boys.

Average scores on the perceived autonomy in using DT index were just slightly but significantly lower among senior-cycles students compared to those at junior cycle, while first- and second-generation students had significantly higher average scores than their native peers. Students in the most socio-economically advantaged (ESCS) quartile had the highest average scores on the perceived autonomy in using DT scale of the four ESCS groups.

Key points from Chapter 4

The overall average scores for Irish students on both the subject-related use of DT during class time and outside of class time indices in 2018 were substantially and significantly lower than the respective OECD and EU averages. Countries with particularly high mean scores on both of these indices included the United States, New Zealand, Australia, Sweden, and Denmark. There is a strong positive correlation (.72) between subject-related use of DT inside and outside of class time at the country level, which suggests a mutually reinforcing relationship between the two. It should be noted that these measures are based on students' reports of how much time they spend using DT during and outside of class time but do not capture how such technologies are being used.

The responses of students in Ireland to the individual items of the use subject-related use of DT during class time index indicates that, in 2018, between 62% and 70% reported *never* using DT during class time for five core subject areas (English, mathematics, science, social sciences (such as CSPE or Politics and Society), and a foreign language). Also, between 43% and 66% of students reported *never* using DT outside of class time for these five subject areas.

Subject related use of DT during and outside of class time varied across some of the subgroups of the PISA 2018 population that were examined. For example, average use of DT was lowest among students in boys' secondary schools, while mean scores on these two indices did not vary significantly by school DEIS status or urban/rural location. Further, higher rates of usage of DT for subject learning both inside and outside of class time were found among students in the most socio-economically advantaged group. Interestingly, senior cycle students used DT for subject learning more than junior cycle students during class time, while the opposite was the case for DT usage outside of class time.

In contrast to low rates of subject-related use of DT inside and outside of class time, students in Ireland in 2018 reported higher than average levels of perceived competence and autonomy in using DT than students on average across both the EU and the OECD. As these indices are based on students' own judgements of their competence and autonomy, they are subjective in nature and this should be kept in mind when interpreting the results for these scales.

The two countries with the highest average scores on the perceived competence in using DT index were Sweden and the United Kingdom, while France and Germany recorded the highest average scores on the perceived autonomy in using DT scale. The country-level correlation between student perceived competency and autonomy in using DT is moderate to strong and positive (.53), meaning that countries with a high mean score on one index tended to have a high mean score on the other.

Average scores on the perceived competence and autonomy in using DT scales did not vary across school DEIS status or urban/rural location; however, average levels of perceived autonomy (but not competence) in using DT were significantly higher in boys' secondary and mixed secondary schools relative to girls' secondary schools. This school-level difference in perceived autonomy in using DT is related to the finding that, on average, girls had significantly lower autonomy scores than boys did. Girls also had, on average, significantly lower scores on the perceived competence in using DT index than boys had, although the difference was not as large. Higher average scores on the perceived competence and autonomy in using DT scales were also found among first- and second-generation students (relative to native students) and among students in the uppermost socio-economic quartile (relative to their less advantaged peers).

Section 5: Summary and implications

The analyses in this report drew on information relating to digital technologies collected in PISA 2012, 2015 and 2018. PISA, a study of the OECD, collects information from nationally representative samples of 15-year-old students and their principals. The PISA study offers an excellent basis for the analyses as it provides high-quality and detailed data every three years that can be used to monitor trends over time, and permits robust international comparisons. Depending on the year in question (2012, 2015 or 2018), results for Ireland can be compared against 20- to 22-country EU averages, and 31- to 32-country OECD averages.

International and national context

In the broader European context, the Digital Education Action Plan (DEAP) 2021-2027 is a flagship initiative to support sustainable and effective adaptation of the education and training systems of EU member states to the digital age. The DEAP is underpinned by a competency framework, DigComp, that describes digital competence in five areas and 21 sub-competencies (Vuorikari et al., 2022). It is also supported by SELFIE, a free, customisable school reflection and planning tool; and SELFIE for TEACHERS, a reflective tool for primary and post-primary teachers.

The International Computer and Information Literacy Study (ICILS) is an important means of monitoring digital competence of lower post-primary students and is linked to monitoring efforts at EU level. In the next cycle of ICILS (2023), which is conducted every five years, 30 countries (including 20 EU countries) will take part. Ireland does not currently take part in ICILS and the next opportunity for Ireland to do so will be in 2028, which will be after the lifetime of the current national Digital Strategy for Schools to 2027 (DoE, 2022; described further below).

Recent Europe/EU-wide comparative reviews (European Commission/EACEA/Eurydice, 2019; Beblavý et al., 2019) highlight the diversity across countries/systems examined in their digital technology policies, curricula and assessments as well as challenges and potential gaps. For example, the assessment of digital competence within national assessment systems was (as at 2018/19) sparse at primary level across Europe. At upper post-primary level, the certification of digital competence at the end of schooling tended to be limited to specific cohorts of students. Ireland is among the countries which (as at 2018/19) did not certify students' digital competence at the end of post-primary schooling (though Computer Science has recently been introduced as a Leaving Certificate subject), nor did it implement national assessments of digital competence at primary or post-primary levels.

Comparisons of EU countries on an index of readiness for digital lifelong learning (IRDLL) ranks Ireland 12th of the 27 countries on the overall IRDLL index. Estonia, the Netherlands, Finland, Luxembourg, Malta and Cyprus are ranked as the top five. The middling performance of Ireland on this index is characterised by its relatively strong performance on learning participation and outcomes, this being undermined by a shortage of up-skilling initiatives and the absence of a sustainable, long-term vision. According to this analysis (Beblavý et al., 2019), Ireland's average digital skills remain comparatively low, ostensibly due to a need for more support to enable changes in pedagogical practices; better funding and co-ordinating efforts; and targeted investment for digital skills education in schools.

Turning to the national context of this report, a recent review of Ireland's Digital Strategy for Schools (DSS) 2015-2020 (Butler & Leahy, 2022) indicates that overall the DSS has been successful and impactful. The vision of the new DSS to 2027 (DoE, p. 11) is to *empower schools to harness the opportunities of digital transformation to build digital competence and an effective digital education ecosystem so as to develop competent, critically engaged, active learners while supporting them to reach their potential and participate fully as global citizens in a*

digital world. While the new DSS makes reference to the EU DEAP, DigComp and SELFIE, its three pillars are not exactly aligned with European developments but rather build on the 2015-2021 DSS. Implementation plans for the DSS are yet to be published, with the first of these to cover 2022-2024, so it remains to be seen whether or to what extent Ireland adopts DigComp.

Butler and Leahy (2022) identify five priorities from their effectiveness review for consideration under the DSS to 2027, and these are consistent with findings from a longitudinal evaluation of the Digital Learning Framework (DLF; Cosgrove et al., 2019; Feerick et al., 2021):

- Development of curricular specifications to embed the development of digital competencies development.
- Digitally supported assessment, both of learning, and for learning (i.e., summative and formative).
- A coherent, flexible and sustainable model of TPL for teachers.
- Support for school leaders to incorporate DLF into school planning and improvement activities.
- Equitable access to broadband (particularly at primary level) in conjunction with effective technical support.

The DLF is regarded as a significant accomplishment of the first DSS and also features prominently in the DSS to 2027. It is a resource to guide schools on how best to effectively use digital technologies to transform their teaching, learning and assessment practices. The notion of embedding DT into teaching, learning and assessment is a key aim or feature of the DLF. As noted by an evaluation of the DLF, however (Cosgrove et al., 2019; Feerick et al., 2021, 2022), there is diversity in the manner in which embedding is understood in schools, and evidence that standards associated with levels of effective and highly effective practice need to be clarified.

Recent analyses of PISA 2018 data (OECD, 2021) suggests that at post-primary level, relatively good school ICT infrastructure is not matched by levels of usage or opportunity to learn digital skills at school in Ireland, which fall well below OECD averages. There is also growing interest in and awareness of the importance of 'non-achievement' measures from large-scale assessments such as PISA. For example, PISA student questionnaire measures of ICT competence and ICT autonomy, though not 'traditional' educational outcomes *per se,* have been identified in recent research as being of importance in their own right due to their associations (across 42 countries) with enjoyment of science, interest in broad science topics, science self-efficacy, and epistemological beliefs about science (Areepattamannil & Santos, 2019).

This report also represents a move away from the more 'traditional' achievement-based outcomes and focuses solely on digital-technology related indicators. The publication of this report comes shortly after the publication of the national DSS to 2027 and EU DEAP 2021-2027 and is timely, given that the DoE has not yet published its DSS implementation plan. The indicators chosen for analysis, which covers post-primary level only, have been done so with the aim of addressing an ongoing need to monitor DT in education and to attempt to address existing evidence gaps. It should be noted that the data on which the analyses are based are from 2012, 2015, and 2018, and much has changed since 2018 particularly with the onset of the Covid-19 pandemic. Nonetheless, these analyses provide a useful set of baseline and pre-pandemic benchmarks against which data from the next two cycles of PISA (2022 and 2025) can be assessed – both of which occur during the lifetime of both the national DSS to 2027 and EU DEAP 2021-2027.

Trends in infrastructure, access and use 2012-2018

Research Question 1: How does Ireland compare with the OECD and EU averages on PISA 2012, 2015 and 2018 indicators of digital technology (DT) access and use at home and school, and school DT infrastructure indicators?

Students in Ireland reported similar rates of access to DT in school compared with the EU and OECD averages in 2012, 2015 and 2018. However, reported DT usage during school time in Ireland was considerably and significantly lower than on average across the EU and OECD across all three cycles examined. Meanwhile, students' reports of access to digital technologies at home was significantly higher in Ireland than at the EU and OECD averages for each of 2012, 2015 and 2018. Despite comparatively high rates of home access, Irish students' reported use of digital technologies outside of school to support their learning was substantially and significantly lower than the EU and OECD averages in all three cycles. Thus, patterns of students' home use of DT for learning mirrors the comparatively low rates of students' usage of DT during school time.

Rates of internet connectivity for school devices were almost universal across Ireland and on average across participating EU and OECD in 2012, 2015 and 2018. This is a broad indicator, and does not provide information on quality or speed of connection. Over the same time period, there has been an increase in computing devices per student in Ireland, the EU and the OECD. However, the increase in devices per student is smaller in Ireland than on average across the EU and the OECD and the number of devices per student in Ireland was significantly below the EU and OECD averages in 2015 and 2018. It is noted that the number of devices per student is a broad indicator and it does not capture information on the quality of devices.

Albeit that the school infrastructure indicators examined are broad and quantitative (i.e. not capturing the quality of infrastructure available), these findings are of concern since average to good rates of school infrastructure and student access to devices at school and at home are not translating to actual levels of usage of digital technologies by students for their learning at school or at home.

Schools' capacity to use digital technologies to support teaching and learning and policies related to digital technologies, 2018

Research Question 2: How does Ireland compare with the OECD and EU averages on PISA 2018 indicators of schools' capacity to use DT to support teaching and learning and policies related to DT?

In 2018, the Irish mean score on an index (developed by the authors of this report) of the school's capacity to support teaching and learning using digital technologies (DT), as reported by principals, was significantly lower than the mean for both the EU, and the OECD. An analysis of principals' responses to the eleven items of the index reveals variations in the perceived adequacy of various aspects of schools' DT. In particular, levels of perceived adequacy of technical support staff was very low, with only 21% of students in schools where this was perceived to be adequate. This is of concern since it can be reasonably assumed that adequate technical maintenance and support is a precursor to the effective use of available DT infrastructure for teaching, learning and assessment. Technical support and maintenance is an area that has been flagged in both the DLF longitudinal evaluation (Cosgrove et al., 2019; Feerick et al., 2021) and in the review in the baseline report for the DSS to 2022 (Butler & Leahy, 2022).

Of a total of eight DT-related policy areas, on average, students in Ireland were in schools with 4.5 policies in place. This is slightly but significantly higher than both the EU and OECD averages (4.0). Further analysis of the eight individual policy areas showed that while many Irish principals reported that their school had

policies relating to general procedures and safe use of DT, there was a lower emphasis on policies and procedures designed to strategically enhance the use of DT for teaching, learning and assessment.

Several countries had higher mean scores than Ireland on both of the indices examined in this section. High levels of school DT capacity were recorded for Switzerland, the United States, Turkey, Norway, Slovenia, Austria, Denmark, Lithuania, and Sweden; while high numbers of school DT policies were found in the Netherlands, the United Kingdom, Norway, the United States, Australia, New Zealand and Canada.

Research Question 3: Are there differences within Ireland across schools in schools' capacity to use DT to support teaching and learning and policies related to DT (by DEIS, sector/gender composition, urban/rural location)?

In Ireland, no statistically significant differences were observed in the average number of policies related to DT by DEIS status, sector/gender composition or urban/rural location. On the school capacity to use DT to support teaching and learning index, non-DEIS schools scored, on average, significantly higher than DEIS schools, i.e. non-DEIS schools' capacity to enhance learning and teaching using digital devices was significantly higher than that of DEIS schools in Ireland. Mean scores on the school capacity to use DT to support teaching and learning index did not vary significantly by urban/rural location or sector/gender composition of the school.

Student use, competence and autonomy related to digital technologies, 2018

Research Question 4: How does Ireland compare with the OECD and EU averages on PISA 2018 indicators of student DT use, competence and autonomy?

On average, students in Ireland reported significantly lower subject related use of DT during class time and outside of class time in 2018 when compared to OECD and EU averages. Countries with particularly high mean scores on both of these indices included the United States, New Zealand, Australia, Sweden, and Denmark. There is a strong positive correlation (.72) between subject-related DT use during and outside of class time at the country level, which suggest a mutually reinforcing relationship between the two.

The responses of students in Ireland to the individual items that make up the subject related use of DT during class time index indicate that, in 2018, between 62% and 70% reported *never* using DT during class time for five core subject areas (English, mathematics, science, social science subject such as CSPE or Politics and Society, and a foreign language). Also, between 43% and 66% of students reported *never* using DT outside of class time for these five subject areas. Usage of DT for learning mathematics was particularly low, both inside and outside of class time.

In contrast to low rates of subject-related usage of DT during and outside of class time, students in Ireland in 2018 reported higher than average levels of perceived competence and autonomy in using DT than students on average across both the participating EU and OECD countries. The two countries with the highest mean scores on the perceived competence in using DT index were Sweden and the United Kingdom, while France and Germany recorded the highest mean scores on the perceived autonomy in using DT scale. The country-level correlation between student perceived competency and autonomy in using DT is moderate to strong and positive (.53), meaning that countries with a high mean score on one index tended to have a high mean score on the other.

The responses of students in Ireland to the individual items that make up the perceived autonomy and perceived competence in using DT indices showed that considerable majorities of students agreed with the items/statements comprising these measures.

Research Question 5: Are there differences within Ireland across student (gender, junior/senior cycle, immigration status, economic, social and cultural status [ESCS]) and school characteristics (DEIS status, sector/gender composition, urban/rural location) with respect to self-reported DT use, competence and autonomy?

Self-reported usage of DT during and outside of class time varied across some of the subgroups of the PISA 2018 population that were examined. For example, on average, students in boys' secondary schools reported lower usage when compared to students in other school types, while students in the most socio-economically advantaged group reported significantly higher rates of use both during and outside of class time. On the other hand, mean scores on these two indices did not vary significantly by school DEIS status or urban/rural location.

Mean scores on the perceived competence and autonomy in using DT scales did not vary across school DEIS status or urban/rural location. However, on average, levels of perceived autonomy (but not competence) in using DT were significantly higher among students in boys' secondary and mixed secondary schools relative to those in girls' secondary schools. The school-level difference in perceived autonomy in using DT is related to the finding that, on average, girls reported significantly lower levels of autonomy in using DT than boys did. Girls also, on average, reported significantly lower levels of DT competence when compared to boys, although the difference was not as large. Furthermore, on average, higher levels of perceived competence and autonomy in using DT were found among first- and second-generation students (relative to native students) and among students in the uppermost socio-economic quartile (relative to their less advantaged peers).

Caveats

PISA provides rigorous and robust measures that can be used to monitor trends over time both within and across countries. However, some caveats should be borne in mind:

- The study is not specifically designed to permit evaluative monitoring of national initiatives such as the DSS to 2027, although it does provide indicators that are relevant to monitoring this strategy.
- The PISA data on digital technologies covers the areas of infrastructure, access, usage, and perceived competence and autonomy. It does not inform other areas that would be relevant to the DSS to 2027 such as curriculum content/design and teacher professional learning/education.
- PISA is a cross-sectional rather than a longitudinal study, meaning that it cannot be used to assess change over time within the same individuals or schools.
- PISA is designed to measure and monitor population-level contexts, characteristics and outcomes. This means that while the samples of 15-year-old students are representative of their respective populations, comparisons by subgroups of the population become somewhat less reliable, particularly when subgroups contain relatively small numbers of schools or students. This does not mean that the comparisons of subgroups are biased; rather, it means that the measurement and sampling error associated with subgroup estimates is larger and therefore less sensitive to detecting differences between small subgroups. It should also be noted that the PISA design excludes small percentages of students (up to 5%) for who the assessment may not be suited; for example, students with some kinds of special educational needs and/or who may have very limited experience in the language of instruction. This means that the results of the study should not be used to inform policies about these particular subgroups of the school-going population.
- Some of the DT indicators considered in this report are rather broad in nature. In particular, two of the measures that were derived from school principals' responses (number of devices per student, and proportion of devices connected to the internet), do not provide information about the quality of those

devices or the stability or speed of connection. Therefore they should be interpreted with their broad nature in mind. We return to this latter point later in this section, under Research Implications.

Policy implications

The review of recent national and international policy and data in the area of digital technology and education indicates a need in Ireland for an over-arching competence framework to accompany any implementation plan with actions and targets. Indeed, an implementation plan for 2022-2024 has been indicated in the new national DSS to 2027, which was published in April. However, national policy in digital technologies has been criticised recently (Beblavý et al., 2019) for not having an overall vision or long-term plan. A debate and informed-decision making on the adoption (or not) of the EU DigComp framework would appear to be an urgent policy matter, and one which should include a consideration of the links between primary, post-primary, and further and higher education, as well as between education, employment and social inclusion sectors of our society and government.

The review indicated a need for the development of instruments that would allow the assessment and monitoring of digital competence at school and national levels. The introduction of Computer Science as an examined subject at post-primary level is very welcome, but it will not inform ongoing monitoring of the national DSS to 2027. A recent European comparative review (European Commission, EACEA, & Eurydice) has noted the diversity across European education systems in how digital competence is assessed, and among whom. This review found that assessment of digital competence within national assessments (for standards monitoring purposes) at primary level was quite sparse, as at 2018/2019, but more widespread at post-primary level. Ireland does not currently implement national assessments of digital competence at either primary or post-primary levels. Nor does Ireland currently take part in the International Computer and Information Literacy Study (ICILS). The next cycle of ICILS in which Ireland could participate is 2028, which is after the lifetime of the current DSS to 2027. A longitudinal national evaluation of the Digital Learning Framework (DLF) is due for completion at the end of 2022. While this study has provided useful evidence of impact, improvement and challenges (e.g. Cosgrove et al., 2019; Feerick et al., 2021, 2022), it is not a true impact evaluation since no assessment of digital competence was included in the design of the DLF evaluation study. This observation may be linked to the fact that although the DLF includes statements of effective and highly effective practice relating to DT, there is evidence that digital competence standards or benchmarks and notions of embedding vary quite widely across schools. This is not surprising in the absence of a competence framework and instrument with which to assess and monitor digital competence levels.

Any plans to develop assessment and monitoring of digital competence under the new DSS to 2027 should be within an overarching framework that links to curriculum and teacher professional development, which is governed by a robust project plan and timeline, and is adequately resourced so as to permit the development of high-quality assessment instruments. A comprehensive assessment of digital competence would need to include both cognitive and non-cognitive components. There is potential at primary level to build strategically on national assessment infrastructure that already exists, such as the National Assessment of Mathematics and English Reading (NAMER) at primary level. NAMER normally occurs every five years or so, with the most recent one implemented in 2021. At post-primary level, the only assessment that Ireland participates in that yields a significant amount of relevant information and data for the purposes of monitoring the new DSS to 2027 is PISA. As noted earlier, PISA is not designed to assess or evaluate specific national initiatives so any meaningful effort to monitor and support the implementation of the new DSS to 2027 would need to consider how best to achieve this within the current system, and in such a way as to maximise compatibility and continuity with assessment and monitoring efforts at primary level.

This said, there is a need to continue to monitor PISA data (and other relevant sources of information) since it is yet too soon to know the medium-term impacts of the pandemic. The extremely low levels of usage of DT

for learning by students both in and outside of school observed in 2018 are very concerning – this is despite higher than average levels of access to DT and of perceived competence and autonomy in using DT. There will be opportunities in the next two cycles of PISA (2022 and 2025) to monitor these indicators during the lifetime of the new DSS to 2027. It should also be noted that a new assessment of Learning in the Digital World, which aims to measures students' capacity to engage in knowledge building and problem solving using computation tools, will be included as part of PISA 2025.

This report also provided data and evidence to underline further the urgent need to prioritise technical support and maintenance. This issue arose in the review of the first DSS (Butler & Leahy, 2022), and the evaluation of the DLF (Cosgrove et al., 2019; Feerick et al., 2021). Technical support and maintenance emerged as the aspect of schools' capacity to use DT to support teaching and learning that was lowest of eleven areas considered in the analyses of the PISA 2018 data, with only around one in five students in schools where principals agreed that the technical support and maintenance were sufficient to support teaching and learning. The provision of high-quality and sustained technical support and maintenance is of critical importance when one considers that this underpins the basis for the effective deployment and efficient usage of infrastructural and other resources.

The analyses in this report also confirm that there is a need to achieve both targeted and overall improvements to schools' capacity to use DT to support teaching and learning, with evidence to support the continued targeting of resources to DEIS schools. The extension of DEIS in March 2022[24], underpinned by refinements to the model used to identify schools, is very welcome. The results from PISA 2018 indicate a need to monitor how supports in DEIS schools are being translated into DT infrastructure and usage.

The results of the PISA 2018 analyses also confirm stated efforts in the new DSS to 2027 to address gender-related disparities relating to DT. In particular, the PISA 2018 results indicate a need to build perceived competence and autonomy in using DT among girls in Ireland.

The report identifies EU and OECD countries that have high average performance on the indicators considered. These countries include (as examples) Australia, Denmark, New Zealand, the Netherlands, and Sweden. A comparative review of the digital technology-related policies and practices in a sub-set of these countries, targeted to specific areas that have proved challenging (for example models of technical support provision to schools) could be valuable as it may help to identify implementation features that could be adopted for the DSS to 2027.

In summary, the policy implications of the report are:

- A need for an overarching digital competence framework that incorporates a single definition of digital competence and which cuts across all levels of the education system and has strategic links with the employment and social inclusion sectors.
- A need for the resourcing, development and implementation of an assessment and monitoring strategy for the new DSS to 2027 that is linked to an overarching competence framework, from which standards and targets may be drawn.
- A need to strategically examine the national and international assessment programme in order to maximise efficiencies and fit to the new DSS to 2027 monitoring and assessment requirements.
- Confirmation of the urgent need to prioritise technical support and maintenance within the implementation planning and resourcing of the new DSS to 2027.
- A need to remain aware of and concerned about the low levels of DT usage for educational purposes by PISA students and monitor these with subsequent cycles of PISA (2022 and 2025).

24 https://www.gov.ie/en/publication/a3c9e-extension-of-deis-to-further-schools/

- Confirmation of the need to target supports for DT usage, competence and autonomy among less socio-economically advantaged schools and students.
- Confirmation of the need to target efforts at increasing digital competence (including autonomy and confidence) among girls.
- Merit in targeted comparative policy analysis of a small number of countries with strong track records to identify features of models of digital technology-related policy and practice to inform implementation of the DSS to 2027.

Research implications

The above policy implications indicate a need for a dedicated national research and evaluation strand to support a coherent, strategic and well-planned approach, both to support and monitor the implementation of the new DSS to 2027. The research efforts to support policy monitoring and implementation could include but are not necessarily limited to the following activities:

- Desk-based/case study review to inform digital competence framework adoption;
- The development of sustainable and well-fitting reflective tools for schools and teachers that complement and augment existing practices, possibly using SELFIE and SELFIE for TEACHERS as a basis;
- The development of high-quality assessment and monitoring tools and reporting; and
- Desk-based comparative country analysis of countries with excellent track records in digital technology education in order to identify best practice models or model features for consideration in Ireland.

This report focused on post-primary level, and the review has indicated a need to prioritise research efforts in this area in depth at primary level, since current data on students' competence are simply not specific enough when compared to post-primary level.

The gender- and socio-economic related disparities in DT usage, as well as perceived competence and autonomy in using DT, were noted as findings with policy implications. The subgroup analyses in this report should be explored further, since the current analyses examined subgroups within a bivariate analysis (one characteristic at a time). It would be worth exploring, for example, whether gender and socio-economic related disparities in perceived competence and autonomy in using DT operate independently or interactively, since these findings could have implications for the targeting of resources and supports.

Finally, the report noted that some of the school-level measures of DT infrastructure are rather general and quantitatively focused in the case of PISA. There would be merit in building on the valuable foundation that already exists by discussing this issue in the international fora for these studies (international governing board meetings; project manager meetings; research conferences), with the aim of supporting improvements internationally in the measurement and regular comparative assessment of digital infrastructure/ecosystems and competence.

In summary, the research implications of this report indicate a need for a dedicated and funded research and evaluation strand in the area of digital technologies in education to inform the implementation of the new DSS to 2027 which could include:

- Desk-based/case study review to guide digital competence framework adoption;
- Development of reflective tools for schools and teachers that fit well with current practices, possibly using SELFIE and SELFIE for TEACHERS as a basis;
- Development of assessment and monitoring tools and reporting;

- Desk-based comparative country analysis of countries with excellent track records in digital technology education in order to identify best practice models for consideration in Ireland;
- Further analysis of gender- and socio-economic disparities in DT access, competence and autonomy;
- Efforts and advocacy at international level to support improvements to the international measurement of DT-related indicators in large-scale assessments such as PISA.

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Appendix: Additional data tables

Table A3.1. Means and standard deviations for individual countries on the school DT capacity and school DT policies indices, 2018

		School DT capacity				School DT policies			
Country	**EU**	*Mean*	*SE*	*Lower 95CI*	*Upper 95CI*	*Mean*	*SE*	*Lower 95CI*	*Upper 95CI*
Australia		63.86	0.62	62.63	65.08	5.81	0.07	5.68	5.94
Austria		68.48	1.29	65.95	71.02	3.69	0.14	3.42	3.97
Belgium	X	57.57	0.87	55.87	59.27	4.02	0.12	3.78	4.26
Canada		61.61	0.76	60.12	63.10	4.93	0.08	4.78	5.09
Chile		52.78	1.47	49.90	55.65	2.93	0.16	2.63	3.24
Czech Rep	X	57.12	0.85	55.44	58.79	3.83	0.11	3.62	4.03
Denmark	X	68.52	0.92	66.72	70.32	4.55	0.12	4.32	4.79
Estonia	X	60.80	0.53	59.75	61.84	4.00	0.08	3.85	4.15
Finland	X	55.22	0.86	53.53	56.91	4.14	0.13	3.89	4.39
France	X	57.05	1.08	54.94	59.17	4.55	0.15	4.25	4.84
Germany	X	43.16	1.23	40.75	45.57	3.38	0.14	3.11	3.64
Greece	X	45.89	1.09	43.75	48.03	2.68	0.15	2.38	2.97
Hungary	X	49.99	1.22	47.61	52.37	2.68	0.14	2.40	2.95
Iceland		61.28	0.08	61.14	61.43	4.00	0.01	3.98	4.03
Ireland	**X**	**49.50**	**1.51**	**46.54**	**52.46**	**4.50**	**0.15**	**4.22**	**4.79**
Israel		49.33	1.27	46.84	51.82	4.63	0.18	4.28	4.97
Italy	X	54.33	0.95	52.47	56.18	4.20	0.14	3.92	4.48
Japan		39.24	1.39	36.51	41.97	3.09	0.17	2.76	3.42
Korea		57.45	1.36	54.79	60.12	4.30	0.19	3.93	4.68
Latvia	X	56.62	0.63	55.38	57.85	3.11	0.07	2.96	3.26
Lithuania	X	69.12	0.55	68.03	70.20	3.03	0.07	2.90	3.16
Luxembourg	X	59.89	0.03	59.83	59.94	4.79	0.00	4.79	4.79
Mexico		43.59	1.31	41.02	46.17	3.69	0.16	3.38	4.00
Netherlands		62.33	1.10	60.17	64.49	4.95	0.16	4.65	5.26
New Zealand		62.99	0.83	61.36	64.61	6.08	0.12	5.85	6.31
Norway		66.30	0.94	64.46	68.14	5.55	0.10	5.36	5.73
Poland	X	54.90	0.89	53.16	56.64	3.97	0.11	3.76	4.19
Portugal	X	44.73	1.00	42.77	46.70	3.62	0.13	3.37	3.87
Slovak Rep	X	56.82	0.80	55.26	58.39	3.66	0.10	3.46	3.86
Slovenia	X	68.13	0.22	67.71	68.56	3.44	0.02	3.39	3.48
Spain	X	45.82	0.71	44.43	47.22	3.16	0.08	3.00	3.33
Sweden	X	72.49	1.26	70.03	74.95	4.46	0.15	4.16	4.76
Switzerland		65.47	1.43	62.67	68.28	3.80	0.17	3.47	4.13
Turkey		66.13	1.36	63.46	68.80	3.94	0.20	3.55	4.32
UK	X	57.95	1.21	55.57	60.32	5.17	0.14	4.89	5.45
USA		66.09	1.54	63.07	69.11	5.58	0.15	5.28	5.88
OECD average		57.57	0.17	57.23	57.91	4.11	0.02	4.07	4.15
EU average		57.24	0.20	56.84	57.64	3.89	0.03	3.84	3.94

Table A4.1. Means, standard errors and 95% confidence intervals for individual countries on the subject-related use of DT during and outside of class time indices, 2018

		Subject-related DT use: during class				Subject-related DT use: outside class			
Country	**EU**	*Mean*	*SE*	*Lower 95CI*	*Upper 95CI*	*Mean*	*SE*	*Lower 95CI*	*Upper 95CI*
Australia		0.69	0.02	0.65	0.73	0.45	0.02	0.42	0.49
Belgium	X	-0.24	0.02	-0.28	-0.20	-0.18	0.01	-0.21	-0.15
Chile		-0.13	0.02	-0.17	-0.09	0.18	0.02	0.14	0.21
Czech Rep	X	-0.32	0.02	-0.35	-0.28	-0.21	0.02	-0.25	-0.17
Denmark	X	1.63	0.02	1.59	1.67	0.76	0.02	0.72	0.80
Estonia	X	0.01	0.02	-0.02	0.04	0.00	0.01	-0.03	0.03
Finland	X	0.09	0.02	0.05	0.13	-0.20	0.02	-0.23	-0.16
France	X	-0.20	0.02	-0.23	-0.17	-0.12	0.01	-0.15	-0.09
Germany	X	-0.24	0.02	-0.28	-0.20	-0.01	0.02	-0.05	0.02
Greece	X	-0.42	0.02	-0.47	-0.38	-0.31	0.02	-0.34	-0.28
Hungary	X	-0.31	0.02	-0.35	-0.27	-0.13	0.02	-0.16	-0.09
Iceland		0.46	0.01	0.43	0.49	0.04	0.01	0.01	0.06
Ireland	**X**	**-0.37**	**0.03**	**-0.43**	**-0.32**	**-0.30**	**0.02**	**-0.34**	**-0.25**
Israel		-0.07	0.02	-0.12	-0.03	-0.11	0.02	-0.15	-0.07
Italy	X	-0.04	0.02	-0.08	0.01	0.14	0.02	0.11	0.18
Japan		-0.60	0.03	-0.66	-0.55	-0.86	0.01	-0.89	-0.83
Korea		0.08	0.03	0.03	0.13	-0.45	0.02	-0.48	-0.41
Latvia	X	-0.13	0.01	-0.16	-0.11	0.11	0.02	0.07	0.14
Lithuania	X	0.03	0.01	-0.00	0.06	0.17	0.02	0.14	0.21
Luxembourg	X	-0.35	0.02	-0.38	-0.32	-0.12	0.01	-0.14	-0.09
Mexico		-0.33	0.02	-0.37	-0.29	0.19	0.02	0.16	0.23
New Zealand		0.61	0.02	0.57	0.66	0.33	0.02	0.29	0.38
Poland	X	-0.22	0.02	-0.26	-0.19	0.26	0.02	0.23	0.29
Slovak Rep	X	-0.01	0.02	-0.05	0.02	-0.06	0.02	-0.09	-0.03
Slovenia	X	-0.41	0.01	-0.43	-0.38	-0.12	0.01	-0.15	-0.09
Spain	X	-0.09	0.02	-0.13	-0.05	-0.07	0.01	-0.10	-0.05
Sweden	X	0.89	0.04	0.81	0.97	0.43	0.03	0.37	0.48
Switzerland		-0.24	0.03	-0.29	-0.19	-0.22	0.02	-0.25	-0.19
Turkey		0.23	0.03	0.17	0.29	-0.02	0.02	-0.05	0.02
UK	X	-0.24	0.03	-0.29	-0.19	0.34	0.02	0.30	0.38
USA		0.39	0.04	0.32	0.47	0.32	0.03	0.26	0.39
OECD average		0.00	0.00	-0.00	0.01	0.01	0.00	0.00	0.01
EU average		-0.05	0.01	-0.06	-0.04	0.02	0.00	0.01	0.03

Table A4.2. Means, standard errors and 95% confidence intervals for individual countries on the perceived DT competence and perceived DT autonomy indices, 2018

		Perceived DT competence				Perceived DT autonomy			
Country	**EU**	*Mean*	*SE*	*Lower 95CI*	*Upper 95CI*	*Mean*	*SE*	*Lower 95CI*	*Upper 95CI*
Australia		0.18	0.01	0.16	0.20	0.15	0.01	0.12	0.17
Austria	X	0.00	0.02	-0.03	0.03	N/A	N/A	N/A	N/A
Belgium	X	0.06	0.01	0.03	0.08	0.04	0.01	0.01	0.07
Chile		0.07	0.02	0.04	0.11	-0.04	0.02	-0.08	-0.01
Czech Rep	X	-0.18	0.02	-0.21	-0.15	-0.15	0.02	-0.18	-0.13
Denmark	X	0.22	0.01	0.20	0.25	0.08	0.02	0.05	0.11
Estonia	X	-0.02	0.02	-0.05	0.01	-0.03	0.02	-0.06	0.00
Finland	X	-0.02	0.01	-0.05	0.00	0.16	0.01	0.14	0.19
France	X	0.21	0.01	0.18	0.24	0.26	0.01	0.23	0.29
Germany	X	0.08	0.01	0.06	0.11	0.37	0.02	0.34	0.40
Greece	X	0.05	0.02	0.02	0.08	-0.13	0.02	-0.16	-0.10
Hungary	X	0.06	0.02	0.03	0.09	-0.05	0.02	-0.08	-0.02
Iceland		-0.07	0.02	-0.11	-0.03	0.20	0.02	0.16	0.25
Ireland	**X**	**0.18**	**0.02**	**0.15**	**0.21**	**0.07**	**0.02**	**0.04**	**0.11**
Israel		-0.04	0.02	-0.08	0.00	0.02	0.02	-0.01	0.06
Italy	X	-0.03	0.01	-0.06	-0.00	-0.11	0.01	-0.14	-0.09
Japan		-0.83	0.02	-0.86	-0.80	-0.18	0.02	-0.21	-0.14
Korea		-0.32	0.01	-0.35	-0.30	-0.21	0.01	-0.24	-0.19
Latvia	X	-0.12	0.01	-0.14	-0.09	-0.03	0.01	-0.06	-0.01
Lithuania	X	0.03	0.02	-0.00	0.06	0.17	0.02	0.14	0.21
Luxembourg	X	0.00	0.01	-0.03	0.02	0.07	0.01	0.05	0.10
Mexico		0.03	0.02	-0.01	0.08	-0.25	0.02	-0.30	-0.21
New Zealand		0.18	0.01	0.15	0.20	0.10	0.01	0.07	0.12
Poland	X	0.01	0.02	-0.02	0.05	-0.02	0.02	-0.05	0.01
Slovak Rep	X	-0.20	0.02	-0.23	-0.16	-0.34	0.02	-0.38	-0.30
Slovenia	X	0.04	0.02	0.00	0.07	-0.19	0.01	-0.21	-0.16
Spain	X	0.14	0.01	0.12	0.16	0.08	0.01	0.06	0.10
Sweden	X	0.26	0.01	0.23	0.29	0.12	0.02	0.09	0.15
Switzerland		0.02	0.02	-0.02	0.06	0.11	0.02	0.08	0.15
Turkey		-0.12	0.02	-0.16	-0.08	-0.20	0.02	-0.24	-0.17
UK	X	0.30	0.02	0.27	0.33	0.08	0.02	0.05	0.12
USA		0.13	0.02	0.09	0.16	-0.04	0.02	-0.08	-0.01
OECD average		0.01	0.00	0.00	0.02	0.00	0.00	0.00	0.00
EU average		0.05	0.00	0.04	0.06	0.02	0.00	0.02	0.02

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