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Beyond the curriculum: access, socio-economic status and digital competence in K-12 policy across 18 education systems[1]

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Abstract: Governments worldwide are embedding digital, media and artificial intelligence (AI) skills in school curricula, but it remains unclear whether curriculum design shapes learning outcomes. This paper compares official K-12 policy documents from 18 education systems and combines three strands of evidence: an exploratory statistical analysis relating curriculum characteristics (legal status, mode of integration, explicit AI literacy content, degree of centralisation) to international indicators of digital competence; a synthesis of ICILS 2023 findings on the individual determinants of Computer and Information Literacy (CIL); and a pilot mapping of digital equity measures, such as device and connectivity subsidies, weighted funding and universal entitlements. No curriculum characteristic showed a robust association with the outcome indicators, although the small samples (4–18 systems) limit inference. ICILS 2023 instead identifies socio-economic status and home access to devices and connectivity among the strongest correlates of CIL. Only eight systems pair their curriculum with income-targeted support, and one guarantees universal device access. We argue that digital curriculum reform and equity-in-access policy should be designed and evaluated jointly, and we propose testing this hypothesis formally in future research.

Keywords: digital curriculum policies; digital equity; Computer and Information Literacy (CIL).

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1. Introduction

In recent years, various governments around the world have responded to the digital transformation by integrating digital, media and artificial intelligence (AI) skills into school curricula through a range of regulatory approaches (Casal-Otero et al., 2023; European Commission, 2020; Ng et al., 2021; Voogt & Roblin, 2012). It remains far less clear whether these design choices have an impact on what pupils are actually able to do. This paper was carried out to analyse a dataset of 31 official policy documents from 18 education systems and to investigate how differences in curriculum design relate to digital competence outcomes. The question is addressed

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EDIZIONI UNIVERSITARIE ROMANE
editoria scientifica dal 1952

through three strands of evidence: (1) an exploratory system-level analysis linking curricular characteristics to international indicators of digital competence; (2) a synthesis of the findings from ICILS 2023 (International Computer and Information Literacy Study) on the individual determinants of Computer and Information Literacy (CIL); (3) a pilot mapping of digital equity measures (subsidies for devices and connectivity, weighted funding formulas, universal rights) that may or may not accompany the curriculum of each system. The analysis indicates that no curricular characteristic is robustly associated with outcomes, whilst socio-economic status and household access to devices and connectivity are among the strongest correlates of CIL.

2. Data, indicators and analytical approach

The corpus comprises 31 official documents (curricula, reference frameworks, strategies and standards) from 18 education systems: ten EU Member States (Estonia, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, Spain and Sweden) and Australia, Canada, England, Norway, Singapore, South Korea, Switzerland and the United States. The documents were sourced from official channels and are listed in Table 2 (Section 3); they were categorised according to four characteristics (Table 1). Where a system has multiple documents, the legal status and AI content are assigned the highest value found; integration is classified as 'mixed' if both modes are present; and centralisation is a property of the system. Equity measures were mapped separately (income-targeted scheme, universal entitlement, school infrastructure only, historical scheme only, none identified); the absence of evidence is not evidence of absence.

Table 1. Variables and indicators used in the system-level analysis.

Variable	Coding or source	Systems
Legal status	1 under development; 2 non-binding guidance; 3 intermediate; 4 binding curriculum	18
Integration	Cross-curricular; mixed; subject-based	18
Explicit AI literacy content	0 none; 1 partial; 2 explicit	18
Centralisation	0 decentralised; 1 intermediate; 2 centralised	18
ICILS 2023 CIL	Mean scale score, grade 8 (Fraillon et al., 2025)	10
PIAAC 2023 APS	Mean score, adults 16–65 (OECD, 2024); primary adult indicator	17
PIAAC 2023 numeracy	Mean score, adults 16–65 (OECD, 2024); robustness check	17
DSI 2023	% of adults 16–74 with at least basic overall digital skills (Eurostat, n.d.)	12
DigComp alignment	0 none; 1 implicit or partial; 2 explicit; coded from the country analyses	14

Note. ICILS: Norway tested grade 9 and the United States did not meet sampling requirements (Fraillon et al., 2025). The DSI covers the 12 systems for which Eurostat data were verified. DigComp alignment is not available for Finland, Germany, Canada and Singapore.

The curriculum characteristics have been linked to four outcome indicators (Table 1). ICILS describes the pupils who are most closely aligned with the curriculum; PIAAC and the Digital Skills Indicator (DSI) describe adults, and thus both cumulative formal and non-formal learning; alignment with DigComp (Vuorikari et al., 2022) is coded from the country analyses. PIAAC's Adaptive Problem Solving (APS), the domain closest to digital problem-solving, is the main adult indicator; numeracy is included as a robustness check. The sample sizes vary (10–17 systems) because not all systems participate in every survey. As the unit of analysis is the system, the inference is ecological (Robinson, 1950): the associations describe differences between systems, not between students. For ordinal characteristics, we report Spearman's ρ with a 95% bootstrap confidence interval (5,000 resamples of the systems; Efron & Tibshirani, 1993). Since each characteristic takes on only two to four values, ties are the norm and the asymptotic p-values of ρ are overly optimistic; the primary test is therefore the Kruskal–Wallis (KW; Kruskal & Wallis, 1952) test, which compares the ranks of the outcome across groups of systems. For the 16 tests (four characteristics × four indicators), the p-values are corrected using Holm's method (1979) to limit false positives and are interpreted as graded evidence, rather than as acceptance or rejection thresholds (Wasserstein & Lazar, 2016). Where the groups are completely separate, we add an exact permutation test and estimates obtained by excluding one system at a time. With few systems and various coding choices, the analysis remains exploratory (Lijphart, 1971): small samples have low power and unstable estimates (Button et al., 2013), and analytical flexibility can produce spurious results even unintentionally (Gelman & Loken, 2014).

3. Divergence in digital curriculum design across education systems

Table 2 maps the corpus. It shows systematic variation across four dimensions: legal status, mode of integration, explicit AI literacy content and centralisation; its last column anticipates the equity mapping of Section 4.

These dimensions reflect different conceptions of what digital competence is and where it fits within the school system (Voogt & Roblin, 2012).

Eleven of the 18 systems have at least one binding curriculum document (e.g. Finland, Spain, Sweden, Norway, England); three have documents of intermediate status (Italy, Australia, Singapore), three have only non-binding guidance (Germany, the United States, Canada) and one, the Netherlands, a draft under development. Non-binding documents, such as the Italian National Digital School Plan, the strategy of the German Conference of Education Ministers (KMK, Kultusministerkonferenz, 2016) or the US CSTA standards, provide guidance and fund innovation, but rely on the initiative of individual schools. However, the binding nature of a regulation does not in itself guarantee implementation, given the well-documented gap between regulatory provisions and teaching practice in the classroom (Cuban, 2001; Spillane et al., 2002).

EDIZIONI UNIVERSITARIE ROMANE
editoria scientifica dal 1952

Table 2. Corpus of official K-12 policy documents (31 documents, 18 education systems) and their coded characteristics.

Country	Document	Year	Institution	Coverage	Status	Type	Int.	AI	Sys.	Equity
Finland	National Core Curriculum for Basic Education	2014/16	EDUFI	K–9	Man.	4	C	0		
	National Core Curriculum for General Upper Secondary Education	2019/25	EDUFI	Upper sec.	Man.	4	C	0	1	–
	Framework for Digital Competence	2023	EDUFI	K–12+	Ind.	2	C	0		
Estonia	National Curriculum for Basic and Upper Secondary Schools	2011/24	Harno / MoE	K–12	Man.	4	M	1	2	I
	ProgeTiger Programme (coding and robotics)	2012/24	Harno	K–12	Ind.	2	M	0		
Ireland	Literacy, Numeracy and Digital Literacy Strategy 2024–2033	2024	DoE	K–12	Man.	3	C	0		
	Digital Strategy for Schools to 2027	2022	DoE	K–12	Ind.	2	C	0	2	T
	Digital Media Literacy – Junior Cycle Short Course	2016	NCCA	Lower sec.	Ind.	4	S	0		
Portugal	Decreto-Lei 55/2018 + Aprendizagens Essenciais (TIC)	2018	DGE	K–12	Man.	4	M	0	2	T
	Estratégia para o Digital e a IA na Educação 2024	2024	Gov. of Portugal	K–12+	Ind.	1	C	1		
France	Cadre de Référence des Compétences Numériques (CRCN)	2019	MEN	K–12	Man.	4	C	0	2	T
	Stratégie du numérique pour l'éducation 2023–2027	2023	MEN	K–12	Part.	3	C	1		
Germany	KMK-Strategie Bildung in der digitalen Welt + 2021 and 2024 (AI) recommendations	2016–24	KMK	K–12	Ind.	2	M	1	0	–
Netherlands	Concept Kerndoelen Digitale Geletterdheid (draft)	2024	SLO / OCW	K–9	Draft	1	M	0	1	T
Spain	Real Decreto 157/2022 (primary) + 217/2022 (lower secondary)	2022	MEFP	K–12	Man.	4	C	0	1	T
Sweden	Curriculum for the Compulsory School (Lgr22)	2022	Skolverket	K–9	Man.	4	C	0	1	–
Italy	Piano Nazionale Scuola Digitale (PNSD)	2015/23	MIUR / MIM	K–12	Ind.	2	C	0		
	Guidelines for Civic Education (DM 183/2024)	2024	MIM	K–12	Man.	3	C	0	1	T
	Guidelines on AI in schools (DM 166/2025)[a]	2025	MIM	K–12	Man.	2	C	1		
England	National Curriculum: Computing Programmes of Study	2013/14	DfE	KS1–4	Man.	4	S	0	2	T
Norway	Kunnskapsløftet 2020 (LK20): core and subject curricula	2020	Udir	K–13	Man.	4	C	0	1	–
Switzerland	Lehrplan 21 – Medien und Informatik (German-speaking cantons)	2014/20	D-EDK	K–9	Man.	4	M	0		
	Plan d'études romand – MITIC (French-speaking cantons)	2010/15	CIIP	K–9	Man.	4	M	0	0	–
United States	CSTA K-12 Computer Science Standards	2017/22	CSTA	K–12	Ind.	2	S	1		
	AI and the Future of Teaching and Learning	2023	US DoE (OET)	K–12+	Ind.	2	C	2		
	Final Priority and Definitions: Advancing AI in Education	2026	US DoE	K–12+	Ind.	2	C	2	0	T
Canada	BC Digital Literacy Framework	2022	BC MECC	K–12	Ind.	2	C	1		
	Use, Understand & Engage: Digital Media Literacy Framework	n.d.	MediaSmarts	K–12	Ind.	2	C	n.c.	0	–
Australia	Australian Curriculum: Digital Technologies, v9.0	2022	ACARA	F–10	Man.	3	M	1	1	–
South Korea	2022 Revised National Curriculum + AI Digital Textbooks Strategy	2022	MOE	K–12	Man.	4	M	2	2	U
Singapore	EdTech Masterplan 2030 + AI-in-Education Ethics Framework	2023/24	MOE	K–12	Part.	3	M	2	2	H

Note. Titles are shortened and given in English or in the original language as in the source; full titles, URLs and issuing bodies are in the dataset. Year: adoption/latest revision (n.d. = not dated). Coverage: K–12 = whole school education; "+" = also early childhood, higher or lifelong education; Lower/Upper sec. = secondary level only; F–10 = Foundation–Year 10 (Australia); KS1–4 = Key Stages 1–4 (England). Status: Man. = mandatory; Ind. = indicative; Part. = partially binding; Draft = not yet in force. Type (legal status, as in Table 1): 4 binding curriculum; 3 intermediate; 2 non-binding guidance; 1 under development. Int. = integration: C cross-curricular; S subject-based; M mixed. AI = explicit AI literacy content: 0 none; 1 partial; 2 explicit; n.c. = not covered in the source. Sys. = centralisation of the system: 0 decentralised/federal; 1 intermediate; 2 centralised. Equity (country level, Section 4): T = income-targeted support for devices or connectivity; U = universal; I = school infrastructure only; H = historical scheme only (c. 2000–07); – = none identified. Country-level columns (Sys., Equity) are merged across a country's documents. Institutions: EDUFI Finnish National Agency for Education; Harno Estonian Education and Youth Board; MoE/DoE/MOE Ministry/Department of Education; NCCA National Council for Curriculum and Assessment; DGE Direção-Geral da Educação; MEN Ministère de l'Éducation nationale; KMK Kultusministerkonferenz; SLO National Expertise Centre for Curriculum Development; OCW Ministry of Education, Culture and Science; MEFP Ministerio de Educación y Formación Profesional; MIUR/MIM Italian Ministry of Education (and Merit); DfE Department for Education; Udir Norwegian Directorate for Education and Training; D-EDK German-speaking Swiss Conference of Cantonal Education Directors; CIIP Intercantonal Conference of Public Education (French-speaking Switzerland); CSTA Computer Science Teachers Association; OET Office of Educational Technology; BC MECC British Columbia Ministry of Education and Child Care; ACARA Australian Curriculum, Assessment and Reporting Authority.

[a] Governance guidance for schools rather than a level-by-level curriculum.

As regards curricular integration, seven systems adopt a cross-curricular approach (e.g. Finland, Sweden, Norway), which links digital competence to subject-specific contexts but risks diluting responsibility for it; England favours a dedicated subject, thereby ensuring dedicated time and a clear progression, but running the risk of reducing digital competence to its purely technical dimension; the other ten combine the two models (Estonia, Ireland, Portugal, Germany, the Netherlands, Switzerland, the United States, Australia, South Korea, Singapore) (Bocconi et al., 2016). Federal or cantonal systems (Germany, Switzerland, the United States, Canada) do not provide for a single national curriculum, resulting in internal variability that national comparisons fail to fully capture.

Finally, despite growing international attention to the subject (Long & Magerko, 2020; Miao & Shiohira, 2024; UNESCO, 2022), explicit AI literacy content is still largely absent: only South Korea, Singapore and, in a non-binding form, the United States address the issue comprehensively. Seven further systems (Estonia, Portugal, France, Germany, Italy, Canada, Australia) address it only partially, and in the remaining eight (Finland, Ireland, the Netherlands, Spain, Sweden, England, Norway, Switzerland) no explicit content was identified.

4. Digital equity measures beside digital curricula

The literature on the digital divide has long moved beyond a binary view – which distinguishes between those who have access to technology and those who do not – in favour of a gradual, multi-level understanding of digital inequalities (Helsper, 2021; Livingstone & Helsper, 2007; Selwyn, 2004). Van Deursen and van Dijk (2019) have demonstrated that, even in societies with very high internet penetration, inequalities persist in so-called 'material access': the quality and number of available devices, peripherals, connection stability and maintenance costs, which in turn are associated with differences in skills and in the ways in which technology is used. The availability of a home computer and a stable connection is associated with higher levels of access to information and communication (Fraillon et al., 2020; Kim & Yoo, 2025), and the pandemic has clearly highlighted the scale of the problem. Given the importance of these factors, we examined whether, in addition to the digital curriculum, each system includes a specific equity initiative that addresses the issue of device ownership or home connectivity. Out of 18 systems, 8 report a subsidy explicitly conditional on income or economic disadvantage (Table 2, last column): Ireland, Portugal, France, the Netherlands, Italy, Spain, the United Kingdom and the United States. These measures differ considerably in terms of design, scope and duration. Ireland combines an ICT grant – the amount of which increases where indicators of socio-economic disadvantage are present – with a measure under the Recovery and Resilience Plan for the provision of devices to disadvantaged pupils, explicitly designed to address the digital divide and which concluded in 2023. Portugal and the Netherlands have set up national funds for connectivity and the distribution of devices to disadvantaged pupils: the Dutch programme, funded by the Recovery and Resilience Facility, concluded in 2021, whilst the Portuguese programme is still active and was refinanced in 2025 with €15 million earmarked for pupils from disadvantaged backgrounds (Conselho de Ministros, 2025). France has launched a similar initiative (Territoires numériques

éducatifs), which is, however, experimental and limited to two departments; its nationwide roll-out is accompanied by regional programmes which, in some regions, include a household income threshold. Italy offers a €500 voucher subject to ISEE eligibility criteria, whilst Spain has introduced two measures for the most vulnerable groups (Educa en Digital, 2020–2021, and Plan #DigEdu, from 2021). Both the United Kingdom and the United States have implemented emergency responses to the pandemic: 'Get Help with Technology', through which over 1.3 million devices were made available in England (Department for Education, 2021), and the Emergency Connectivity Fund, which reached 12.7 million pupils. The United States, however, is the only country that also has a long-term structural scheme. Overall, many of these measures were introduced or strengthened as emergency responses to school closures and are therefore temporary in nature. This is by no means a minor issue: a device distributed in 2020 becomes obsolete within a few years, and equitable access requires recurring, rather than one-off, investment. South Korea stands out as the only system in which individual access to a device is guaranteed to all pupils, regardless of their family's financial situation, through a universal, non-means-tested programme linked to the Digital New Deal, which effectively eliminates the device ownership gap irrespective of family income.

A comparison between this model and the targeted benefits described above brings to mind a classic debate in welfare policy: universal programmes, whilst being more expensive, tend to achieve wider coverage and greater political sustainability, whereas means-tested measures concentrate resources on those most in need, but are prone to problems of stigma, non-take-up and the exclusion of households just above the threshold (Korpi & Palme, 1998). It should be emphasised, however, that universal access to a device addresses the first level of the digital divide but does not in itself guarantee the development of skills and self-efficacy. Estonia, by contrast, invests in equity only at the infrastructural level (rural connectivity, the renewal of school equipment) rather than at the individual level, thereby ensuring access at school but leaving access at home to families. Singapore represents a special case: only one long-standing subsidy scheme for devices aimed at low-income families has been identified (approximately 2000–2007), and the remaining gap currently appears to be partially bridged by civic or university initiatives rather than by an up-to-date government programme.

For the remaining seven systems (Finland, Sweden, Norway, Switzerland, Germany, Canada and Australia), no specific programmes were identified. This finding should be interpreted with caution, as the failure to identify a programme indicates a lack of evidence, not necessarily the absence of a policy. Equity can, in fact, be pursued through general welfare mechanisms rather than through sector-specific education policies. This hypothesis is consistent, particularly in the Nordic countries, with welfare models based on universal transfers and services that reduce income inequalities at the source (Esping-Andersen, 1990). On the other hand, three of these seven systems (Germany, Switzerland, Canada) are decentralised, and in Australia the states set their own implementation timelines. In such cases, measures may exist at sub-national level, beyond the scope of a mapping exercise conducted at national level. Overall, the picture that emerges is one of a heterogeneous dimension of equity, often temporary and rarely designed in conjunction with the curriculum, which confirms the need to analyse policies relating to the digital

curriculum and access policies jointly, rather than as separate areas (Warschauer, 2003).

5. Curriculum design and competence indicators: a weak and unstable signal

Table 3 summarises the 16 tests. No curricular characteristic shows a robust association with any indicator: the unadjusted p-values from the Kruskal–Wallis (KW) test range from 0.004 to 1.00 and, following Holm's correction, none fall below 0.05. Legal status is the only characteristic with a positive, albeit weak, relationship with the ICILS 2023 CIL scores (ϱ = 0.58, 95% CI [0.01; 0.90], N = 10; p KW = 0.18; Figure 1). Systems with a compulsory curriculum score an average of 508 points compared with 492 for the other three, but the ranges overlap (495–540 vs 482–502) and all ten score above the ICILS average (476). Integration and centralisation show no association with the indicators (p KW ≥ 0.18) and no characteristic is associated with alignment with DigComp (p KW ≥ 0.13).

Table 3. Association between curriculum characteristics and outcome indicators (system level).

Characteristic	ICILS CIL (N = 10)	PIAAC APS (N = 17)	DSI (N = 12)	DigComp (N = 14)
Legal status	.58 [.01, .90] KW p = .18	.00 [−.50, .48] KW p = .45	.15 [−.66, .79] KW p = .09	.09 [−.44, .55] KW p = .76
Integration	KW p = .45	KW p = .74	KW p = 1.00	KW p = .18
Explicit AI literacy	−.08 [−.83, .71] KW p = .94	−.51 [−.79, −.12] KW p = .12	−.86 [−.89, −.65] KW p = .004	−.02 [−.57, .60] KW p = .13
Centralisation	.55 [−.13, .94] KW p = .25	−.24 [−.61, .18] KW p = .34	−.17 [−.77, .42] KW p = .43	.29 [−.29, .72] KW p = .30

Note. Cells show Spearman's ϱ [95% bootstrap CI] and the Kruskal–Wallis p-value (KW p). Integration is nominal, so only KW p is reported. Holm-adjusted KW p = 1.00 for all cells except AI literacy × DSI (.07). Robustness with PIAAC numeracy (N = 17): legal status ϱ = .06 (KW p = .60); integration KW p = .84; AI literacy ϱ = −.49 [−.79, −.04] (KW p = .13); centralisation ϱ = −.18 (KW p = .35). AI literacy × DSI: leave-one-out ϱ from −.87 to −.84; with Sweden recoded as partial, ϱ = −.82 (DSI) and −.40 (APS; p = .12).

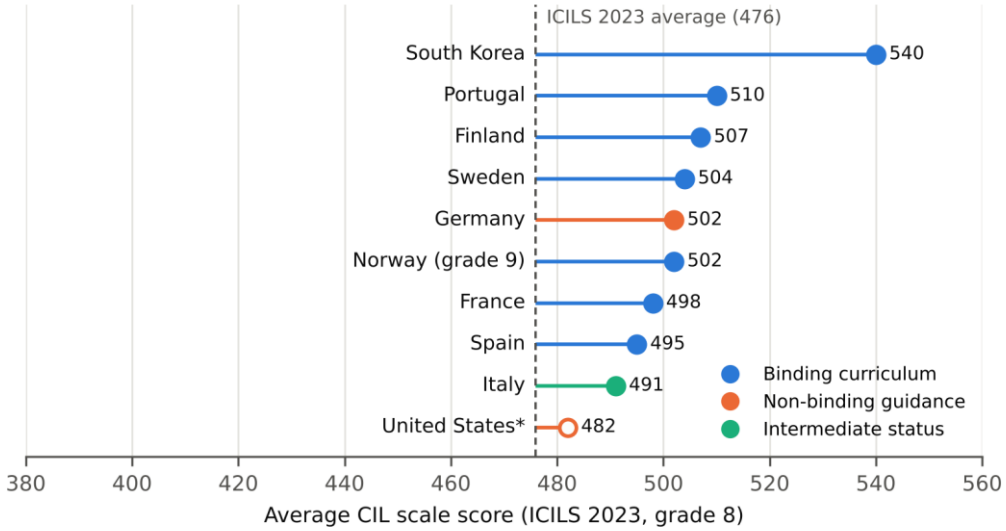


Figure 1. ICILS 2023 CIL scale scores of the ten systems in the dataset by legal status of the curriculum document. *United States: sampling requirements not met; Norway: grade 9. Source: Fraillon et al. (2025), Table 5.1.

The clearest finding concerns AI literacy and runs counter to what one might expect: systems with AI content in the curriculum are those with the lowest outcomes, not the highest. With the PIAAC APS, the association is moderate (ϱ = −0.51 [−0.79; −0.12]; p KW = 0.12). With the DSI, the association is much stronger (ϱ = −0.86 [−0.89; −0.65]; N = 12; Figure 2): the five systems with partial AI content (Estonia, France, Germany, Italy, Portugal) all have a lower DSI than each of the seven systems that do not include such content. Such a clear distinction is unlikely to be due to chance alone (exact permutation test: p = 0.0025; KW: p = 0.004). However, as there are 16 tests, Holm's correction is applied: the KW p-value rises to 0.07 and the permutation p-value to 0.04 (multiplied by 16), so the evidence remains borderline. The result holds up when systems are excluded one at a time and when Sweden – the most questionable case – is recoded as 'partial' (ϱ = −0.82), but it is based on only two groups and 12 systems.

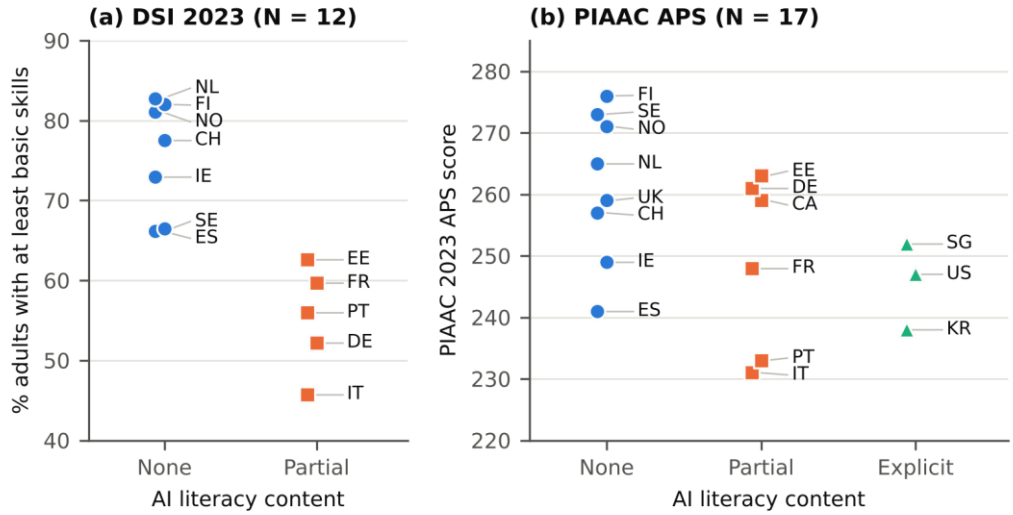


Figure 2. Explicit AI literacy content and adult outcomes: (a) DSI 2023 (N = 12); (b) PIAAC 2023 APS (N = 17). Labels are country codes (UK = England). Sources: authors' coding; Eurostat (n.d.); OECD (2024).

We do not interpret this as a curricular effect. The provisions on AI mostly date from 2023–2026, whilst the outcomes were measured in 2023 and, for adults, reflect decades of prior learning; the DSI is self-reported; and the framework follows regional groupings (Nordic and Atlantic systems). A more plausible interpretation is the reverse: it is likely that in systems with higher DSI scores, there is less of a sense of urgency to define AI literacy, and there is greater openness to a gradual consolidation over time, because digital skills already enable a more informed use of AI. This, of course, remains a hypothesis that cannot currently be verified by cross-sectional data.

In summary, in our data, the formal characteristics of the curriculum (legal status, methods of integration, centralisation, AI content) do not distinguish systems with high outcomes from those with low outcomes. This does not prove that the curriculum is irrelevant: with only 10–17 systems, the analysis has limited statistical power—that is, it captures only broad differences—and the confidence intervals are so wide as to be compatible with both the absence of an effect and effects of moderate magnitude. We can therefore state that no robust association emerges, not that it does not exist. One possible explanation, which these data do not allow us to verify, is that outcomes depend primarily on factors not regulated by the curriculum itself, such as family resources and access to devices and internet connectivity.

6. Individual and household determinants of CIL in ICILS 2023

The ICILS 2023 international report, conducted amongst over 130,000 students across 35 education systems, confirms that individual and family factors are the strongest predictors of CIL (IEA, 2024, Fraillon, 2025). Around half scored below CIL Level 2, demonstrating no more than rudimentary skills. Background characteristics are consistently associated with CIL (Table 4; Kennedy et al., 2025). Three indicators of socio-economic status (SES) – parental education, parental

employment and books at home – show significant gaps ranging from 33 to 48 points in every country, and household ICT resources show gaps of a comparable magnitude: pupils who always have a computer available for homework score 41 points higher across all participating countries. The language spoken at home, migrant background and gender (a female advantage already documented in previous cohorts; Gebhardt et al., 2019) are also associated with CIL, but not in every country.

Table 4. Average differences in CIL scores by student background, ICILS 2023.

Background factor	Contrast	Gap (CIL points)	Countries with a significant gap
Parental education	University degree vs lower	33	All (17–53)
Parental occupation	ISEI ≥ 50 vs < 50	41	All (22–61)
Books at home	≥ 26 vs < 26	48	All (23–73)
PC for schoolwork at home	Always available vs not	41	All (22–67)
Computers at home	≥ 2 vs < 2	36	All (19–64)
Home internet disruption	Fewer vs more issues	22	All but Korea (9–58)
Language at home	Test language vs other	29	22 of 30 (reverse in 2)
Immigrant background	Non-immigrant vs immigrant	15	18 of 32 (reverse in 3)
Gender	Female vs male	19	28 of 32 (male higher in none)

Note. Differences between international averages; the range across countries is in brackets. Source: Kennedy et al. (2025), Tables 6.1–6.9 and H.1–H.6.

In Korea, gender, socio-economic status (SES), duration of computer use and self-efficacy are significant factors, whilst formal ICT training is not (Kim & Yoo, 2025); in 19 countries, SES emerged as a strong predictor (Davis & Dong, 2020). These are bivariate gaps, not net or causal effects, but they recur across different survey cycles (Kennedy et al., 2025). Changes since 2018 illustrate the limited influence of legal status: Italy (intermediate status) gained 30 points, Finland (binding, cross-cutting) lost 24, and France and Portugal showed no significant changes (Fraillon et al., 2025). Two cases do not prove anything, but they are hardly consistent with legal status as a determining factor.

The factors that matter most – family SES, devices and connectivity – are those that are not regulated by curriculum guidelines and that income-targeted measures address in only eight systems (Section 4). This is consistent with the literature on digital divides, in which skills follow resources and social position (Hargittai, 2002, 2010; Robinson et al., 2015; Scheerder et al., 2017; Gui & Argentin, 2011), and offers a plausible explanation for why curricular characteristics show so little variation across systems.

7. Conclusions

The intersection of these three strands clarifies the interpretative framework without offering a definitive, linear and deterministic answer – a finding that is essentially reliable given the latest observations on the SES. Curriculum design differs significantly between systems, but no single characteristic shows a robust statistical association with the measured outcomes. The only strong signal, amongst explicit AI and DSI content, is barely significant after adjustment and more plausibly reflects a reverse relationship: where digital skills are high, AI literacy is less urgent and can be built up gradually. ICILS 2023 identifies SES and home access to devices and connectivity as the strongest correlates of digital literacy, and the mapping shows that only 8 out of 18 systems combine the curriculum with targeted income support, just one with a universal right to such support, and seven with no documented measures.

These strands point in the same direction, but equity has not yet been statistically tested against outcomes; an unidentified programme is not the same as an absent programme; and the analysis at system level is limited, ecological and cross-cutting. South Korea, which combines a binding curriculum with explicit AI content and a universal right to access devices, also has the highest ICILS score of the ten systems (540); however, a single case does not support any inferences, even though it stands out as a unique and highly interesting case. A natural next step is a multi-level model that combines student-level ICILS data with country-level curriculum frameworks, equity measures and teacher competence frameworks (e.g. DigCompEdu; Redecker & Punie, 2017). For policy-makers, the main implication is that digital curriculum reform and equity of access must be designed and evaluated jointly, echoing the question of 'under what conditions' technology enters education (UNESCO, 2023).

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