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UNIFIED AI LITERACY FRAMEWORK FOR SINGAPORE

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UNIFIED AI LITERACY FRAMEWORK FOR SINGAPORE

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EXECUTIVE SUMMARY

Artificial intelligence (AI) is increasingly embedded in how people learn, work and make decisions. While access to AI tools has expanded rapidly with the proliferation and low cost of generative AI tools, this has not translated into evenly distributed benefits. Instead, AI is reshaping existing digital and social inequalities in faster, less visible ways. The resulting “AI divide” reflects not only differences in access, but also uneven exposure to AI-enabled risks, disparities in individuals’ capabilities to engage with AI, and divergent outcomes in learning and economic participation.

In response, governments and organisations worldwide have introduced a growing number of AI literacy initiatives. In Singapore, while this landscape reflects strong national commitment, it also reveals fragmentation across agencies, sectors and target groups. Existing efforts have made meaningful progress in areas such as information literacy and safety. However, other dimensions of AI literacy—including communication and collaboration, content creation, problem solving and workplace application—remain unevenly emphasised. In the absence of a shared reference framework, these variations risk producing inconsistent learning outcomes and uneven preparedness across the population.

This working paper reviews international AI literacy frameworks alongside Singapore's existing initiatives to identify key gaps and areas of convergence. Building on this analysis, it proposes a "Unified AI Literacy Framework for Singapore" that integrates baseline digital skills, AI-specific competences, career-related capabilities and contextual competences such as judgement, adaptability and ethical awareness. The framework is intended to serve as a common reference point for policy design, programme development, and coordination across education, workforce development and community settings.

The proposed framework does not seek to replace regulation, governance mechanisms or institutional accountability for the design and deployment of AI systems. Nor does it assume that AI literacy alone can resolve structural inequalities or mitigate all AI-related risks. Rather, it clarifies what individuals can reasonably be equipped to do, while recognising that responsibility for safe, inclusive and trustworthy AI remains shared across institutions, platforms and policymakers.

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1. BACKGROUND

Artificial intelligence (AI) has emerged as one of the most transformative technologies of the 21st century, reshaping economies, societies and daily life. Advances in machine learning, deep learning and generative AI have enabled machines to perform tasks that were traditionally undertaken by humans. These include analysing complex datasets (Stryker, 2024), generating creative content (Upwork, 2024), supporting medical diagnostics (Khalifa & Albadawy, 2024) and informing financial decisions (Ionescu & Diaconita, 2023). This rapid technological evolution has triggered significant global labour market shifts, generating both enthusiasm and apprehension about AI's growing influence (Google & Ipsos, 2024; Poushter et al., 2025).

Since the publication of IPS Working Papers No. 39, which introduced the Unified Framework for Digital Literacy (UFDL) in Singapore—a framework designed to strengthen policy coherence across digital skills domains (Chew & Soon, 2021)—the technology landscape has changed considerably. Recent research suggests that digital and information processing skills are among those most affected by AI diffusion (Yee et al., 2025).

These developments underscore the need for a dedicated AI literacy framework. Such a framework would help clarify the specific competences required to engage

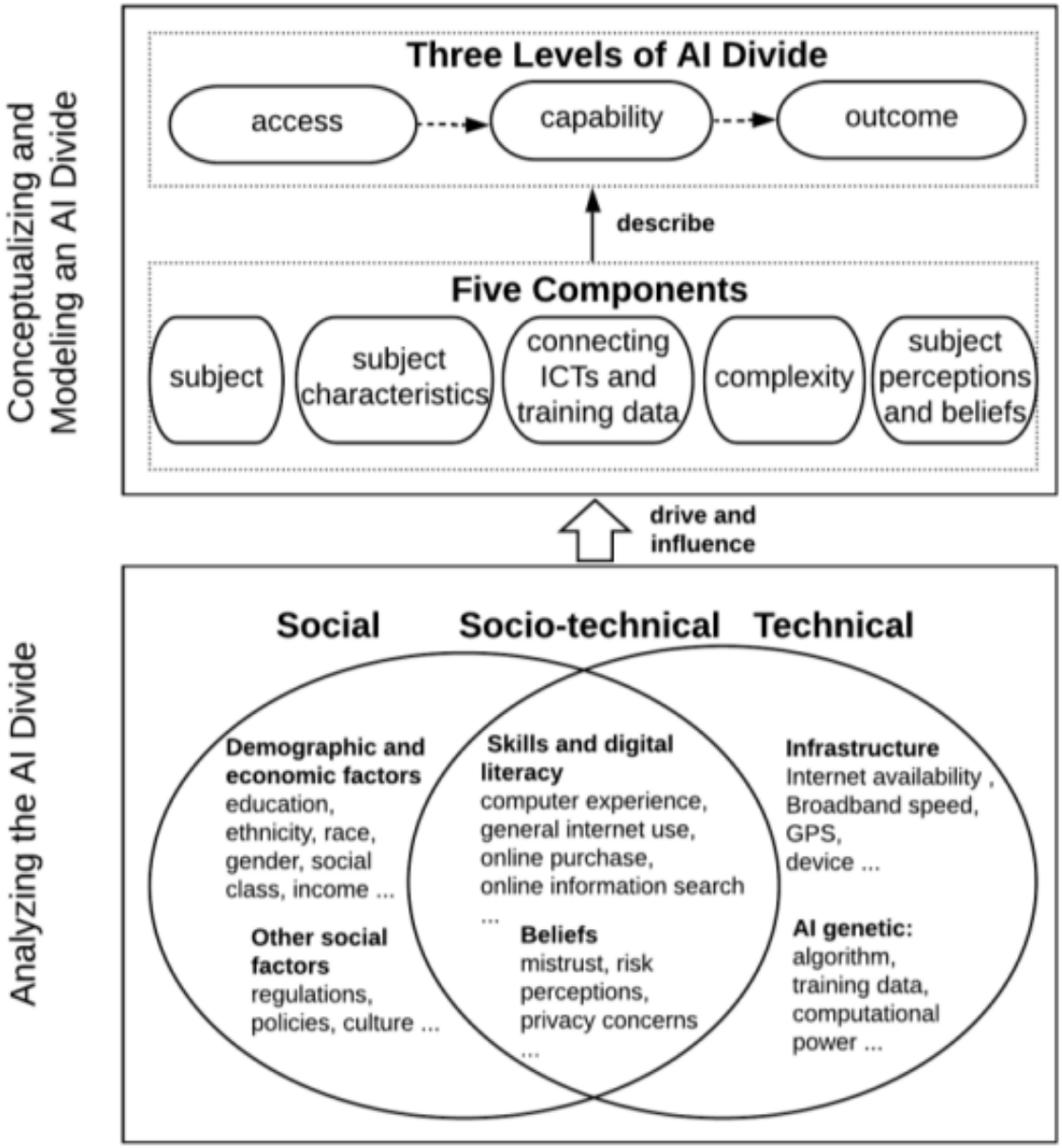
with AI technologies, complementing existing digital literacy efforts rather than replacing them.

2. AN EMERGING "AI DIVIDE"

Despite AI's potential to drive innovation and improve efficiency, its adoption and benefits are unevenly distributed worldwide. This disparity has been termed the "AI divide" (United Nations & International Labour Organization, 2024). Carter et al. (2020) proposed a comprehensive framework conceptualising the AI divide as a subset of digital divide (see Figure 1). The AI divide is defined as "AI-related inequalities about access to AI (the first-level divide), the ability to use AI (the second-level divide), and the outcomes of AI engagement (the third-level divide)" (Carter et al., 2020, p.259).

Importantly, just like the digital divides discussed in Working Papers No. 39, the AI divide is not static: as gaps in one dimension, such as access, begin to narrow, new forms of inequality often emerge in others, like capability and outcomes.

Figure 1: Comprehensive Framework of AI Divide



Source: Carter, L., Liu, D., & Cantrell, C. (2020). Exploring the Intersection of the Digital Divide and Artificial Intelligence: A Hermeneutic Literature Review. *AIS Transactions on Human-Computer Interaction*, *12*(4), 253-275. https://doi.org/10.17705/1thci.00138

Building on the traditional digital divide model, Carter et al. (2020) highlighted the importance of individuals' perceptions, beliefs and attitudes towards AI. Research on technology adoption has shown that individuals' reluctance to embrace new technologies—driven by mistrust, perceived risks and concerns over data privacy—can exacerbate existing digital divides (Fox & Connolly, 2018).

Similarly, recent studies have highlighted that individuals' risk perceptions and trust in AI can influence engagement with AI tools or systems (Marjerison et al., 2025; Sharma et al., 2024). For example, a survey by Salesforce (2024) found high levels of scepticism towards AI among workers in Singapore. Such attitudes may limit individuals' abilities to use AI effectively and reduce the benefits they can derive from engaging with AI. This, in turn, can reinforce existing inequalities in the AI ecosystem.

In practice, the AI divide manifests across multiple interrelated domains. Importantly, exposure to AI-enabled risks can occur even in the absence of direct access to or use of AI tools. The next subsections focus on three outcomes of inequality that are particularly salient for policy and literacy interventions: widening gaps in learning and skills acquisition; disparities in economic stability and employment prospects; and heightened vulnerability to AI-enabled scams and misinformation. Together, these dimensions illustrate how unequal exposure to AI-mediated environments, uneven capabilities to use it, and differential outcomes of

AI engagement interact to shape individuals' exposure to harm, learning trajectories and economic security.

2.1. Widening Learning Gaps

At the access and capabilities level, the AI divide is reflected in unequal opportunities to access AI technologies and to develop the skills and competencies needed to use AI effectively. The integration of AI into educational contexts has transformed learning processes by enabling personalised tutoring. Personalised tutoring systems are designed to adapt to a learner's pace, provide real-time feedback and continuous support. However, there is often unequal access to such systems and learners who have access acquire skills more rapidly, build greater confidence and achieve better learning outcomes compared to their peers who lack access (Katona & Gyonyoru, 2025; Kestin et al., 2025).

Even among those who have access, AI tutoring systems benefit learners unevenly. Learners whose profiles align closely with the system's training data—such as being male, part of a racial majority group, without disabilities and from high-income backgrounds—may be favoured due to inherent biases (Fitas, 2025; Vassel et al., 2024; Weissburg et al., 2025). This results in explanations and feedback that are better tailored to these learners. Conversely, learners from marginalised groups may receive feedback that is less accurate, culturally irrelevant or misaligned with their abilities. Such uneven learning support can constrain skill development and further entrench the existing AI divide.

2.2. Disparities in Economic Stability and Employment Prospects

At the outcomes level, the AI divide is reflected in unequal employment prospects, income stability and career trajectories resulting from AI-driven labour market shifts. In 2025, the World Economic Forum (WEF) published its Future of Jobs Report which underlined how macrotrends, such as AI, are reshaping the labour market. According to the report, 86 per cent of employers expect AI and information processing technologies to transform their businesses by 2030 (WEF, 2025a). However, this transformation is not uniform. AI and information processing technologies are projected to generate 11 million jobs, while simultaneously displacing nine million existing ones (WEF, 2025a). Many of the displaced jobs are routine, administrative or clerical roles (see Figure 2).

Figure 2: Fastest Growing and Declining Jobs by 2030

Source: World Economic Forum. (2025b). *The Future of Jobs Report 2025* [Infographic]. https://www.weforum.org/publications/the-future-of-jobs-report-2025/infographics-94b6214b36/

Similarly, findings from the US Bureau of Labor Statistics (2025) indicate that the impact of labour market changes will vary significantly across occupations. Employment for software developers, for example, is projected to grow by 17.9 per

cent by 2033, reflecting the rising demand for technical skills in an AI-driven economy. In contrast, employment in certain business and financial roles, such as claims adjusters and insurance appraisers, is expected to decline by 4.4 per cent and 9.2 per cent, respectively.

Certain groups are disproportionately affected by AI-driven labour shifts, including freelancers, women and fresh graduates (Dickler, 2025; LinkedIn, 2023; Teutloff et al., 2025). For instance, females face heightened risks due to their concentration in “pink-collared” roles such as clerical and administrative occupations. A recent study showed that 9.6 per cent of female-dominated jobs in high-income countries are at high risk of AI exposure, compared with 3.5 per cent of male-dominated jobs (Gmyrek et al., 2025). Additionally, lower rates of regular generative AI use among females may further constrain their ability to transition into emerging AI complementary roles (Hupfer et al., 2024; Kreacic & Stone, 2024).

Taken together, these trends point to a bifurcated labour market. Workers with AI-related competences are positioned to benefit from productivity gains and new opportunities. In contrast, freelancers, females and fresh graduates face shrinking job prospects and greater labour market instability.

2.3. Increased Susceptibility to Scams and Misinformation

The AI divide is increasingly shaped by unequal exposure to AI-enabled risks embedded in the digital environment. It enables sophisticated financial scams, such as pig butchering scams in which offenders use AI to build trust with victims over time before coercing them into large-scale frauds (Burgess & Newman, 2024). Additionally, AI-generated content, including deepfakes, contributes to the spread of false information (Campbell, 2025; Naffi, 2025).

Older adults are particularly vulnerable to these risks. In the US, for example, losses from AI-enabled elder fraud have increased substantially, rising from $840 million in 2019 to $4.9 billion in 2024 (Federal Bureau of Investigation, 2024). This reflects a form of inequality rooted not in lack of access to AI tools, but in disproportionate exposure to AI-mediated harms without corresponding protective knowledge or safeguards. One possible explanation is that older adults tend to have low AI literacy, which limits their ability to identify AI-enabled online harms (iProov, 2025).[1] These trends underscore the need to enhance AI literacy among older adults, equipping them with the necessary skills to safeguard themselves against AI-enabled harms.

[1] iProov is a global technology company that provides biometric solutions such as biometric verification and authentication (iProov, n.d.).

3. SINGAPORE'S RESPONSE TO BRIDGE THE "AI DIVIDE"

In 2025, Singapore recorded the highest level of regular AI usage among advanced economies, with 73 per cent of the population reporting that they use AI tools or systems regularly (Gillespie et al., 2025). This high level of adoption reflects strong national readiness and openness towards AI, but does not in itself indicate uniform levels of AI competences.

The benefits and attendant risks of AI have elicited wide-ranging policy responses in different jurisdictions. In Singapore, policymakers' approach seeks to maximise gains while minimising risks. This is evident from the government's use of a policy toolkit comprising frameworks, evaluating tools and investments in research and development of AI applications (Soon & Tan, 2023). Singapore's digital transformation agenda is one that continues to evolve in response to emerging technologies. For example, the launch of Smart Nation 2.0 in 2024 marked a strategic shift from Smart Nation initiative 1.0, which had focused on developing digital infrastructure and encouraging technology adoption. The updated vision focuses on harnessing digital technologies in ways that build trust, drive inclusive growth and strengthen community engagement (Prime Minister Office, 2024). These priorities place renewed emphasis on how individuals engage with AI, rather than on access and adoption alone.

To support these goals, different sectors have introduced initiatives to enhance AI literacy across different age groups and sectors. Table 1 presents a non-exhaustive overview of initiatives from both the public and private sectors. Collectively, these programmes demonstrate substantial investment and experimentation in AI literacy, spanning public awareness, formal education and workforce upskilling.

Table 1: Examples of Public and Private Sector Initiatives

Programme / Initiatives	Agency	Description
General AI literacy		
Gen AI literacy workshop[2]	IMDA & DBS Foundation	Equip seniors with basic digital skills such as transacting online, using smart devices and generative AI skills including using tools such as ChatGPT to generate information, and how to stay safe against known risks such as hallucinations and deepfakes.
National Library Board (NLB)'s S.U.R.E. (Source, Understand, Research, Evaluate.) programme and the Cyber Security Agency of Singapore (CSA)'s SG Cyber Safe Students Programme	NLB, CSA	Various programmes by public agencies to raise awareness about AI.

[2] The DBS Foundation held its first Gen AI literacy workshop in August 2025 with IMDA. The bank aims to run 1,000 similar classes over the next three years, covering digital banking, cashless payments and anti-scam awareness.
The workshops use the bank's curated content and IMDA's Digital Skills for Life (DSL) Framework, launched in 2024 to help Singaporeans gain basic digital skills. Updated in 2025 amid rising use of tools like ChatGPT, the framework now includes lessons on using generative AI safely and recognising risks such as hallucinations and deepfakes (Koh, 2025).

Be a Digitally S.U.R.E. Family (A Parenting Toolkit)	NLB	Help parents support their children in navigating the digital environment. The toolkit highlights the advantages and disadvantages of using chatbots, the ease of generating false information using tools such as ChatGPT or Bard, and provides guidance on identifying AI-generated images.
AI Creators	The AI Playroom	A flagship programme enabling children aged 7–13 years old to understand AI, design simple models, use AI tools responsibly and build their own AI systems.
Formal education		
AI Student Outreach Programme	AI Singapore	Aims to promote AI literacy and proficiency among students. Students will gain programming skills like Python and/or R, critical thinking skills, practical experience and knowledge in AI projects.
Code for Fun	IMDA & MOE	The new “AI for Fun” modules are available to all primary and secondary schools. Students will learn about generative AI, smart robots, prompt engineering, use of generative AI for design thinking and how to use AI safely and responsibly.
Generative AI Literacy and Safety	Cyberlite	A workshop that empowers students to become ethical and informed AI users.
Workforce upskilling		
SkillsFuture Singapore (SSG) — SkillsFuture for Digital Workplace 2.0 (SFDW 2.0)	SSG	Equip Singaporeans and enterprises with digital skills to navigate the evolving digital economy.

AI Apprenticeship Programme	AI Singapore	Apprentices will get to work on real-world projects and deepen their skills in AI, machine learning and software engineering as they learn to deploy AI models into production.
GenAI Playbook	IMDA	Equip enterprises with an understanding of generative AI's benefits and transformative potential, the key considerations for implementing generative AI solutions, and practical guidelines on managing risks, governance and security.
AI Ready Programme	UOB FinLab	Tailored for both business and technical leaders, the programme equips small and medium enterprises with the knowledge and tools to explore, adopt and scale AI solutions that deliver tangible business impact.

While numerous programmes and initiatives aim to improve AI literacy, these efforts remain fragmented across different agencies and sectors. The initiatives vary widely in their target audiences, depth of coverage and emphasis on technical, ethical or safety-related competences. The lack of a coordinated strategy results in uneven outcomes as different programmes focus on different AI skills. As a result, participants may develop isolated capabilities without a clear progression or shared baseline. This fragmentation creates gaps in participants' knowledge and limits their ability to engage with AI effectively. It underscores the need for a unified AI literacy framework. Such a framework would consolidate existing initiatives and provide clear benchmarks for skills and knowledge acquisition. It would also

ensure that all segments of society are progressively equipped to interact confidently and responsibly with AI.

4. ASSESSING EXISTING AI LITERACY FRAMEWORKS

To examine whether existing approaches provide a suitable foundation for a coherent AI literacy strategy in Singapore, this section reviews international AI literacy frameworks and Singapore government's current initiatives. The proposed Unified AI Literacy Framework is informed by a systematic review of international frameworks and national initiatives, benchmarked against the European Commission's Digital Competence Framework 3.0. Table 2 below lists the key AI literacy frameworks and programmes reviewed. Programmes by AI Singapore were excluded from this exercise due to insufficient publicly available information on their underlying competency structures at the time of review.

Table 2: Key AI Literacy Frameworks and Programmes Reviewed

Local organisations	**AI literacy frameworks / programmes**
Infocomm Media Development Authority	Digital Skills for Life Framework
Ministry of Education	EdTech Masterplan 2030
Cyber Security Agency of Singapore	SG Cyber Safe Students programme
National Library Board	S.U.R.E programme
International organisations	**AI literacy frameworks / programmes**
European Commission	Digital Competence Framework 3.0

UNESCO	AI Competency Framework for Students AI Competency Framework for Teachers
European Commission and OECD	AI Literacy Framework
Certiport	Generative AI Foundations Certification
ICDL	Artificial Intelligence Module
Microsoft	AI Fluency Learning Path

4.1. Defining AI Literacy

Despite the growing prevalence of AI, there is no universally accepted definition of AI literacy. Scholars and organisations conceptualise AI literacy in different ways. This lack of definitional consensus has implications for policy design, as different framings foreground different skills, audiences and expectations of what AI literacy should achieve.

For instance, Long and Magerko (2020) define AI literacy as:

> "… a set of competencies that enables individuals to critically evaluate AI technologies; communicate and collaborate effectively with AI; and use AI as a tool online, at home, and in the workplace." (p.2)

This definition is further elaborated through a detailed framework of 17 competences that address what AI is, what it can do, how it works and how it

should be used. This highlights that AI literacy encompasses not only technical knowledge but also a responsible and critical understanding of its societal impacts.

In contrast, the Organisation for Economic Cooperation and Development (OECD) define AI literacy as:

> "AI literacy represents the technical knowledge, durable skills, and future ready attitudes required to thrive in a world influenced by AI. It enables learners to engage, create with, manage, and design AI, while critically evaluating its benefits, risks, and ethical implications." (Organisation for Economic Cooperation and Development, 2025, p.6)

While both definitions highlight the importance of ethical awareness and critical thinking, they differ in focus. Long and Magerko (2020) concentrate on the practical competences required for interacting with AI in everyday contexts. In contrast, OECD (2025) frames AI literacy more broadly, with an emphasis on cultivating future ready skills and attitudes.

In Singapore, under the EdTech Masterplan 2030, AI literacy is described as a skill that enables learners to identify, explain and leverage AI in both learning and daily life, while understanding its associated risks (Ministry of Education, 2023). An official parliamentary reply further clarifies that AI literacy in Singapore includes

thinking critically about AI biases, questioning AI outputs and discerning false or misleading information produced by AI models (Ministry of Education, 2025a).

In the absence of a consensus, we evaluate both international and local frameworks against the Digital Competence Framework developed by the European Commission to understand how existing perspectives on the desired competencies and outcomes align and differ.

4.2. Reference Framework: Digital Competence Framework 3.0

The Digital Competence Framework developed by the European Commission is widely recognised as one of the most influential frameworks for conceptualising digital competence. It has been adopted in more than 20 European Union (EU) countries, informed key EU digital policies and guided numerous certification schemes across 25 countries (Centeno & Cosgrove, 2025). The framework delineates the digital knowledge, skills and attitudes required for individuals to operate competently in an increasingly evolving technological landscape (Cosgrove & Cachia, 2025). While DigComp 3.0 is not an AI literacy framework per se, it provides a well-established reference for assessing how AI-related competences are embedded within broader digital capabilities.

The most recent iteration, DigComp 3.0 reflects digital technological developments, trends and practices that have emerged since 2022, along with their implications

for digital competence. It also includes the transversal integration of AI competence across the framework (Cosgrove & Cachia, 2025). Notably, a basic level of digital literacy is a prerequisite for achieving foundational digital competence in DigComp 3.0. This includes access to: (1) reliable high-speed internet, (2) one or more digital devices, (3) technical support and (4) guidance to adapt devices and settings to individual physical, cognitive or psychological needs. Additionally, individuals must possess the ability to decode basic visual, textual and/or audio information (Cosgrove & Cachia, 2025).

Similar to DigComp 1.0 and the subsequent DigComp 2.0, including versions 2.1 and 2.2, DigComp 3.0 is organised around five competence areas (Cosgrove & Cachia, 2025):

1. **Information search, evaluation, management**
    1.1. To articulate information needs, and to search for, locate and retrieve digital information and content.
    1.2. To judge the relevance of the source and its content in digital environments.
    1.3. To critically evaluate digital sources, content and processes used to generate them.
    1.4. To store, manage, organise and analyse digital information and data.

2. Communication and collaboration

2.1. To interact, share, communicate and collaborate in digital environments while being aware of cultural, generational and other diversity and the features and limitations of digital technologies.

2.2. To participate in society through digital technologies.

2.3. To assert one's rights and exercise choice in digital environments.

2.4. To manage one's digital presence, identity and reputation.

3. Content creation

3.1. To create and edit digital content.

3.2. To improve and integrate information and content into an existing body of knowledge while understanding how copyright and licences are to be applied, adopting an ethical and responsible approach in the creation, improvement and integration of digital content.

3.3. To know how to apply computational thinking and programming techniques to give instructions to a computer system.

4. Safety, wellbeing and responsible use

4.1. To protect, devices, content, personal data and privacy in digital environments.

4.2. To support physical, mental and social wellbeing of oneself and others, and to be aware of the benefits and risks of digital technologies for wellbeing and social inclusion.

4.3. To be aware of the environmental impact of digital technologies and their use, to take action to reduce such impact, and to use digital technologies to support sustainability.

5. Problem identification and solving

5.1. To identify and assess needs, and to use digital technologies and adapt digital environments to meet these needs.

5.2. To identify and resolve technical and conceptual problems and problem situations in digital environments.

5.3. To use digital technologies to make improvements in, or new solutions for, processes and products.

5.4. To build capabilities to operate autonomously in digital environments.

5.5. To stay informed about digital technological developments and their implications.

The framework also specifies proficiency levels, with advanced and highly advanced levels requiring individuals to possess prior or specialised knowledge to achieve full competence (Cosgrove & Cachia, 2025). Since the proposed framework is intended for the general public, this review will focus on competences up to the intermediate level. See Appendix A for an overview of the framework, systematically organised by proficiency levels and aligned with the content covered.

4.3. International AI Literacy Frameworks

Several international organisations have developed AI literacy frameworks to guide education and policy efforts. When these frameworks are mapped to DigComp 3.0, a broad alignment is observed across all five competence areas (see Table 3). However, the frameworks differ in audiences, scope and depth and the mapping is therefore indicative rather than definitive. This alignment suggests a growing international consensus that AI competence should be addressed as a transversal skill, rather than as a standalone technical skill.

Table 3: Mapping Competences Under DigComp 3.0 to International Frameworks

DigComp 3.0 Components	AI Competency Framework for Students (AI CFS)	AI Competency Framework for Teachers (AI CFT)	AI Literacy Framework (AI Lit)
Information search, evaluation and management	✓ AI techniques and applications, AI system design	✓ AI techniques and applications	✓ Engaging AI, Designing AI
Communication & collaboration	✓ Human-centred mindset	✓ Human-centred mindset, AI for professional development	✓ Managing AI, Creating with AI
Content creation	✓ AI techniques and applications	✓ AI techniques and applications, AI for professional development	✓ Designing AI, Creating with AI
Safety, wellbeing and responsible use	✓ Ethics of AI	✓ AI pedagogy, Ethics of AI	✓ Engaging AI

Problem identification and solving	✓ AI system design	✓ AI pedagogy, AI for professional development	✓ Designing AI, Managing AI

4.3.1. UNESCO AI competency framework for students

The AI Competency Framework for Students (AI CFS) aims to guide public education systems in developing the competences required by every student and citizen to support the implementation of national AI strategies (Miao & Shiohira, 2024). The AI CFS identifies 12 competency blocks, organised along a two-dimensional matrix. The first dimension encompasses four interconnected aspects of AI competences, and the second dimension defines three levels of progression—understand, apply and create—that students are expected to navigate iteratively (see Table 4).

Table 4: Overview of AI CFS Competences

Competency aspects	Progression levels		
	Understand	Apply	Create
• Human-centred mindset	• Human agency	• Human accountability	• Citizenship in the era of AI
• Ethics of AI	• Embodied ethics	• Safe and responsible use	• Ethics by design
• AI techniques and applications	• AI foundations	• Application skills	• Creating AI tools
• AI system design	• Problem scoping	• Architecture design	• Iteration and feedback loops

Source: Miao, F., & Shiohira, K. (2024). *AI competency framework for students*. United Nations Educational, Scientific and Cultural Organization. https://doi.org/10.54675/JKJB9835

These four competency aspects represent the core skills that students must develop to become responsible users, informed co-creators and future leaders in AI (Miao & Shiohira, 2024):

1. **Human-centred mindset**

    1.1. Promote awareness about the proportionality[3] of specific AI tools for meeting human needs and advancing environmental and ecosystem sustainability.

2. **Ethics of AI**

    2.1. Covers the social and ethical aspects of AI competencies, including the social skills to navigate, understand, apply and contribute to the evolving principles that guide human behaviour across the entire AI lifecycle.

3. **AI techniques and applications**

    3.1. Integrates interconnected conceptual knowledge of AI with practical operational skills through hands-on use of AI tools and real-world tasks.

[3] "The principle of proportionality in AI encompasses the idea that AI systems should be designed and deployed in a manner that appropriately balances risks and benefits, respects human rights, and aligns with societal values and interests." (Miao & Shiohira, 2024, p.80)

4. **AI system design**

    4.1. Covers comprehensive engineering skills that determine the problem scoping, architecture building, training, testing and optimisation of AI systems.

Appendix B presents the four competency aspects, their corresponding competency blocks and the values and skills each block aims to foster.

4.3.2. UNESCO AI competency framework for teachers

The AI Competency Framework for Teachers (AI CFT) supports lifelong professional development by providing a reference for national competency-building and training programmes (Miao & Cukurova, 2024). Its aim is to ensure that teachers can use AI responsibly and effectively while mitigating potential risks to students and society.[4] The AI CFT comprises 15 competency blocks organised along a two-dimensional matrix (see Table 5).

[4] This framework is not designed for teachers who are specialised and tasked to teach advanced AI knowledge and skills (Miao & Cukurova, 2024).

Table 5: Overview of AI CFT Competences

Aspects	Progression		
	Acquire	Deepen	Create
1. Human-centred mindset	Human agency	Human accountability	Social responsibility
2. Ethics of AI	Ethical principles	Safe and responsible use	Co-creating ethical rules
3. AI foundations and applications	Basic AI techniques and applications	Application skills	Creating with AI
4. AI pedagogy	AI-assisted teaching	AI–pedagogy integration	AI-enhanced pedagogical transformation
5. AI for professional development	AI enabling lifelong professional learning	AI to enhance organizational learning	AI to support professional transformation

Source: Miao, F., & Cukurova, M. (2024). *AI competency framework for teachers*. United Nations Educational, Scientific and Cultural Organization. https://doi.org/10.54675/ZJTE2084

These five aspects specify the competencies that teachers need to develop in order to use AI in their teaching practices and professional development (Miao & Cukurova, 2024):

1. **Human-centred mindset**

    1.1. Define the values and critical attitudes teachers need to develop towards human–AI interactions.

    1.2. Teachers are encouraged to cultivate critical approaches for evaluating the benefits and risks of AI, while ensuring human agency and accountability, and understand its societal impacts and implications for citizenship in the AI era.

2. Ethics of AI

2.1. Delineates the essential ethical values, principles, regulations, institutional laws and practical ethical rules that teachers need to understand and apply and adapt.

3. AI techniques and applications

3.1. Specifies conceptual knowledge and transferable skills teachers need to select, apply and creatively customise AI tools for student-centred, AI-assisted teaching and learning.

4. AI pedagogy

4.1. Proposes a set of competencies required for purposeful and effective AI-pedagogy integration. This covers the ability to validate and select proper AI tools and to integrate them into pedagogical strategies to support course preparation, teaching, learning, socialisation, social caring and learning assessment.

5. AI for professional development

5.1. Outlines teachers' capacities to leverage AI for driving their own lifelong professional development.

Appendix C presents each competence area, related competences and outcomes.

4.3.3. AI Literacy Framework (AI Lit)

The AI Literacy Framework (AI Lit) is a joint initiative by the European Commission and OECD. At the time of writing, the framework is in draft form. It is intended for teachers, education leaders, policymakers and learning designers (OECD, 2025). The framework outlines core competences and provides learning scenarios to guide learning materials, curricular standards, school initiatives and responsible AI policies in primary and secondary education. It is organised around four practical domains:

1. **Engaging with AI**

    1.1. Understanding when and how AI is present in everyday tools and critically evaluating its outputs.

2. **Creating with AI**

    2.1. Collaborating with AI tools to support problem-solving and creativity, while considering ethical implications like ownership and bias.

3. **Managing AI**

    3.1. Delegating tasks to AI responsibly, setting guidelines and ensuring human oversight.

4. **Designing AI**

    4.1. Exploring how AI works and how to build or adapt systems to solve real-world problems.

While the domains are presented as practical entry points, they are not strictly sequential and may overlap in real-world learning contexts and learner needs. Learners may develop proficiency across multiple domains without necessarily achieving full mastery in any single one. In total, the four domains encompass 22 competences. Appendix D outlines each domain along with its related competences, the knowledge, skills and attitudes that learners should develop, and the intended outcomes associated with each competency. See Appendix E, Tables E1 and E2 for a description of the relevant skills and attitudes.

4.4. Existing AI Literacy Efforts in Singapore

Across the four national efforts targeting the general public that are reviewed, there is strong alignment in information and data literacy, as well as safety (see Table 6). This suggests a shared national priority on safe and effective use of AI. Other aspects of AI literacy, such as communication and collaboration, content creation

and problem solving, receive varying levels of emphasis across agencies. This uneven coverage reinforces the case for a unifying framework that clarifies baseline expectations and progression across domains.

Table 6: Mapping DigComp 3.0 to Four National Efforts

DigComp 3.0 Components	Digital Skills for Life Framework (IMDA)	EdTech Masterplan 2030 (MOE)	SG Cyber Safe Students Programme (CSA)[5]	NLB S.U.R.E. (NLB)[6]
Information search, evaluation and management	✓	✓	✓	✓
Communication & collaboration	X	✓	X	X
Content creation	X	✓	X	X
Safety, wellbeing and responsible use	✓	✓	✓	✓
Problem identification and solving	X	✓	X	X

4.4.1. Digital Skills for Life (DSL) Framework

The Digital Skills for Life (DSL) Framework was launched by the Infocomm Media Development Authority (IMDA) in 2024. It provides learning resources and

[5] As part of the initiative, CSA published an infographic specifically focused on deepfakes, rather than addressing AI more broadly.
[6] Under the S.U.R.E. programme, the scope was limited to generative AI content and deepfakes, instead of covering AI in a broader context.

materials to equip Singaporeans with the digital knowledge and skills they need. These skills help them perform everyday online tasks safely and confidently, navigate the digital environment and protect themselves from online risks (Digital for Life, n.d.). The framework outlines five digital competences applicable across digital applications (see Table 7).

Table 7: DSL Competences

Competency	**Description**
Set up and use smart devices	Set up and operate basic mobile device hardware and software.
Explore information online	Search, view and retrieve information online.
Communicate online	Connect with others online.
Transact online	Conduct online transactions, including e-payments, with government agencies and other service providers.
Be safe, smart and kind online	Safeguard against cyber threats, protect personal information and maintain a positive online presence.

Adapted from: Digital for Life. (n.d.). *Be future ready with Digital Skills for Life.* https://www.digitalforlife.gov.sg/about/our-projects/be-digitally-ready-with-digital-skills-for-life

In 2025, generative AI content was included under the "Explore information online" and “Be safe, smart and kind online” competencies (Ministry of Digital Development and Information, 2025). It covers the following:

Explore information online

- Common generative AI tools and features
- Use of these tools to search for and generate information for daily living needs (e.g., planning itineraries, finding food or leisure options)

Be safe, smart and kind online

- Introduction to generative AI
- Risks associated with generative AI (i.e., misinformation, impersonation, deepfake)
- Measures to mitigate risks under NLB's Source, Understand, Research, Evaluate (S.U.R.E) framework

4.4.2. EdTech Masterplan 2030

EdTech Masterplan 2030 was launched by the Ministry of Education (MOE). Its goal is to address the opportunities and challenges of the post-COVID educational landscape, in which technology has become a critical enabler of learning (Ministry of Education, 2025b).

Under Strategic Thrust Two, the Ministry aims to strengthen the development of students' digital literacy and technological skills. In support of this, the "Find, Think, Apply, Create" framework introduced in MOE's National Digital Literacy Programme is further expanded into nine digital competences (Ministry of

Education, 2023). Appendix F presents the nine competencies along with their associated outcomes.

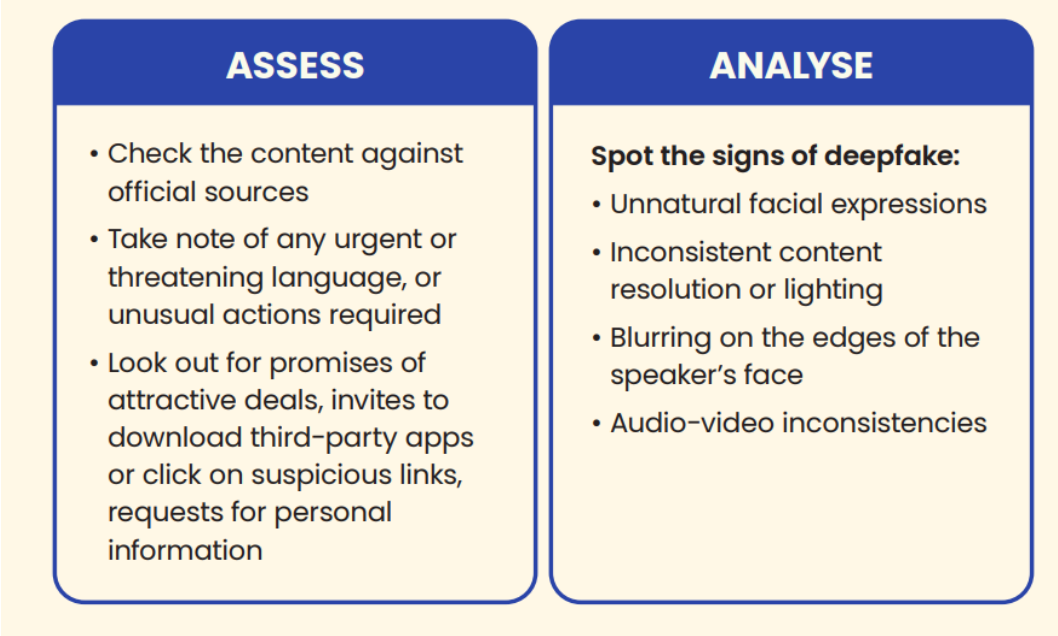
In addition to digital literacy, students' technological skills will also be strengthened. A key focus area is developing AI literacy. This seeks to equip students with the ability to understand AI; recognise and explain its potential benefits, limitations and risks; and apply AI tools effectively (Ministry of Education, 2023).

4.4.3. SG Cyber Safe Students Programme

SG Cyber Safe Students Programme is a cybersecurity education initiative by Singapore's Cyber Security Agency (CSA). It focuses on raising awareness of cybersecurity risks and promoting good cyber practices among three key stakeholders in the school ecosystem: (1) students, (2) educators and (3) parents (Cyber Security Agency, 2025a).

To tackle the emerging threat of deepfakes, Cyber Security Agency of Singapore (2024) published an infographic for both students and educators. The infographic highlights two key steps individuals can take to determine whether content has been deepfaked (see Figure 3).

Figure 3: Screenshot of Two Key Strategies to Discern Deepfake Content



Source: Cyber Security Agency of Singapore. (2024, June 13). *Spot the Signs of Deepfakes* [Infographic]. Digital for Life. https://www.digitalforlife.gov.sg/learn/resources/all-resources/spot-the-signs-of-deepfakes

Additionally, CSA released an in-depth article for educators to support them in teaching students how to identify and protect themselves from deepfake content. The article introduced the "3A" approach to discerning deepfakes (Cyber Security Agency of Singapore, 2025b). The three components are: (1) assess the message, (2) analyse audio-visual elements and (3) authenticate content using tools.

4.4.4. The S.U.R.E campaign

The National Library Board's (NLB) S.U.R.E. programme was launched in 2013 to raise public awareness about the importance of information searching and critical

evaluation (National Library Board, n.d.-a). To enhance public understanding of generative AI and deepfakes, NLB has updated its programmes — S.U.R.E for Public, S.U.R.E for Schools, Read to be S.U.R.E. series.

As part of the S.U.R.E for Public initiative, NLB has published a resource to educate the public about generative AI (National Library Board, n.d.-b). The resource explains how chatbots, image generators, search engines and video generators work. Additionally, it provides tools to help individuals identify AI-generated text and images.

Under S.U.R.E for Schools, NLB has introduced new modules on Digital Wellness (DW) and Digital Safety (DS) to equip students with essential knowledge and skills for navigating the current complex digital information landscape. These modules include content on deepfakes and generative AI, tailored for students across different educational levels (National Library Board, n.d.-c; National Library Board, n.d.-d; National Library Board, n.d.-e). Appendix G shows the modules and learning outcomes relating to deepfakes and generative AI for each education level.

“Read to be S.U.R.E” is an initiative under NLB’s Libraries and Archive Blueprint 2025. It aims to inform the public about trending issues through curated resources and related programmes (National Library Board, n.d.-f). As part of this initiative, NLB has published thematic issues addressing current digital concerns. Volume 3

issue 1 provides an overview of emerging generative AI trends, including key advantages and disadvantages (National Library Board, 2025a). Volume 4, issue 1 discusses deepfake trends, highlighting their consequences and outlining remedies to combat deepfakes (National Library Board, 2025b).

Given the uneven emphasis across national initiatives on communication and collaboration, content creation and problem-solving, the first recommendation of this working paper is to develop a unifying AI literacy framework that includes these additional components. This should extend beyond awareness and safety to cover practical use and creation, with clear expectations for how learners should progress across domains.

Additionally, as some national initiatives focus solely on generative AI, the framework should cover AI more broadly, ensuring that learners develop comprehensive AI competences. This enables them to understand AI more generally and apply AI (not just generative AI) responsibly and effectively across diverse technologies and contexts.

5. WHY CAREER-RELATED COMPETENCES AND CONTEXTUAL CAPABILITIES MATTER

IPS Working Papers No. 39 highlighted an urgent need to create a set of baseline career-related competences, alongside curriculum benchmarks. It argued that such an approach would allow Singaporeans to build their foundational capabilities while progressively broadening and deepening their skillsets over time (Chew & Soon, 2021).

With the pervasive integration of AI technologies into workplaces, the proposed Unified AI Literacy Framework must extend beyond baseline digital skills to include career-related competences to reflect the new demands and affordances introduced by AI. Career-related AI competences refer to the ability to use, interpret, analyse and critically assess data, information and AI-generated content within specific occupational or professional contexts (Chee et al., 2024). These competences extend beyond basic awareness of AI to include applied, contextualised and judgement-based capabilities that enable effective and responsible workplace use.

A key national initiative addressing these needs is SkillsFuture for the Digital Workplace 2.0 (SFDW 2.0), led by SkillsFuture Singapore (SSG). The SFDW 2.0 is a nationwide initiative that equips Singaporeans with relevant digital skills. It offers training in areas such as automation, cybersecurity, data analytics, AI,

generative AI and other in-demand digital tools (SkillsFuture Singapore, 2025). For employers, the programme aims to equip staff with the necessary aptitudes and skills to navigate technological changes and leverage emerging opportunities in the future economy.

The learning outcomes of SFDW 2.0 include being:

1. aware of the jobs and digital skills required in the current and future digital economy;
2. able to work in a technology-rich environment and know the associated cybersecurity risks;
3. aware of various digital applications and tools in work applications, including widely applicable national or sectoral platforms;
4. aware of how data and information can be used;
5. able to gain hands-on experience in using AI (including generative AI) tools to improve productivity and effectiveness at the workplace;
6. able to perform functional outcomes through use of digital tools and software to access various learning paths and content; and
7. able to follow or develop a post-course action plan to continue learning and further deepen skillsets in the areas of automation, cybersecurity risk, data analytics, AI (including generative AI) and in-demand digital tools.

In addition to workforce-wide training, SFDW 2.0 also offers sector-specific and contextualised content for industries such as built environment, food services, manufacturing, retail, tourism and transportation (SkillsFuture Singapore, 2025).

However, career-related competences alone are insufficient. Contextual competences are becoming equally, if not more, important than career-related competences. IPS Working Papers No. 58 identified contextual competences such as problem-solving, critical thinking, analytical thinking, learning to learn, adaptability and ethical awareness as critical for the optimal performance of a worker (Soon et al., 2024). Additionally, Brynjolfsson et al. (2025) found that AI adoption disproportionately affected early-career workers aged 22–25 years who were in occupations highly exposed to automation. Even after controlling for firm-time effects, employment in these roles declined by approximately 16 per cent from 2021 to 2025. These findings underscore the importance of developing tacit and transferable capabilities, particularly for early-career workers navigating AI-driven labour markets.

5.1. Emerging Research on Career-Related Competences and Contextual Capabilities

LinkedIn's 2025 Skills on the Rise lists AI literacy[7] as the fastest-growing skillset globally and across job functions (Dewar, 2025; LinkedIn News, 2025). Between 2023 to 2024, AI literacy skills added by LinkedIn members have grown by 177 per cent, a rate nearly five times faster than overall skills growth (LinkedIn, 2025). In addition to AI-specific capabilities, employers continue to prioritise transversal skills such as strategic thinking, communication and adaptability (Dewar, 2025).

Similarly, a survey of employers across the Asia-Pacific region indicates a strong demand for AI-related technical skills, including AI development, the use of AI-enabled tools, advanced digital marketing,[8] augmented and virtual reality applications and basic digital marketing[9] (Access Partnership, 2024). Importantly, employers emphasise that technical proficiency alone is insufficient. Transversal competences, particularly creative thinking and design, critical thinking, ethics and risk management, are viewed as essential complements to emerging AI-related capabilities.

[7] AI literacy skills include: AI builder, AI prompting, Anthropic Claude, ChatGPT, DALL-E, generative AI, Generative AI Studio, generative AI tools, generative art, GitHub Copilot, Google Bard, Google Gemini, GPT-3, GPT-4, LLaMA, Microsoft Copilot, Microsoft Copilot Studio, Midjourney, multimodal prompting, prompt engineering, Stable Diffusion (Stanford University Human-Centered Artificial Intelligence, 2025, p.438).
[8] Advanced digital marketing encompasses the skills to design and manage digital advertising campaigns, as well as to analyse data in order to evaluate the effectiveness of marketing strategies across digital platforms (Access Partnership, 2024).
[9] Basic digital market entails the ability to use digital channels to reach, engage and convert audiences, such as creating social media content for advertising (Access Partnership, 2024).

In the European context, Cedefop (2025) conceptualises AI literacy for workers as an integrated set of ethical, technical, analytical and judgement-based competences. Workers should be able to demonstrate knowledge of, and the ability to explain, the following nine pillars:

1. ethical issues raised by AI (e.g. privacy, bias, discrimination, misinformation, accountability, singularity);
2. potential applications of AI and its impact on the world;
3. role that humans play in developing AI tools or systems;
4. understanding how a computer or machine learns from data using algorithms;
5. understanding how a computer or machine recognises images, text or other input data to develop AI tools or systems;
6. having the knowledge to know when it is appropriate to use a computer or machine over human skills to carry out a task;
7. analysing data collected in a spreadsheet or database (e.g., identify patterns, trends or correlations among variables);
8. interpreting the results of AI applications and understand their limitations; and
9. distinguishing technologies that use AI from those that do not.

Complementing these perspectives, the UK AI Skills Framework provides a structured approach to identifying and categorising career-related competences

(Skills England, 2025). The framework primarily focuses on the effective use, application and oversight of generative AI in real-world contexts, including text and image generation, summarisation and AI-driven recommendations.

Within this scope, the framework identifies three broad categories of AI-related skills:

- **Technical skills**: practical, applied competencies required to operate, monitor and guide AI systems effectively in real-world settings.

- **Responsible or ethical skills**: the ability to uphold ethical principles, ensure transparency and accountability, assess bias and apply legal and regulatory standards when using AI tools.

- **Non-technical skills**: foundational, transferable competencies needed to understand, engage with and critically evaluate AI tools for efficiency, even without technical expertise.

The framework further differentiates AI competences across three levels of engagement: entry-level, mid-level and managerial. While the specific skills required vary by role and responsibility, the framework adopts a cumulative approach, where competencies at higher levels build upon those acquired at earlier stages. Table 8 presents an overview of this AI skills framework, organised by job level and skill category.

Table 8: UK Skills Framework by Job Level and Skill Category

Job Level	Technical AI Skills	Responsible and ethical AI Skills	Non-Technical AI Skills
Entry-level	Write prompts for AI tools Operate embedded AI features (e.g. autocomplete, transcription tools) Perform routine digital tasks (such as emails) using AI tools	Assess accuracy and appropriateness of AI for tasks Identify bias in AI outputs Assess risks in AI-generated decisions Apply data privacy practices Apply data protection guidance	Use basic AI tools to complete routine tasks Test AI tools for application in your tasks Apply new AI tools to support daily tasks Assess when to seek support in using AI tools Provide basic observations about AI results to colleagues Prepare for training on AI tool use
Mid-level	Use AI tools in job-specific workflows Apply AI tools to role-specific tasks Use low-code AI platforms for automation Create basic dashboards or scheduling tools using AI features	Evaluate AI-generated content for accuracy and relevance Identify bias in AI outputs and apply corrective measures Assess AI outputs and apply professional judgement Guide ethical decision-making in team settings Apply relevant policies and frameworks to ensure responsible AI use in your role context	Coordinate AI use with colleagues in shared processes Use AI insights to improve service provision or decision-making Provide feedback to improve AI use within teams Apply new AI tools and support peer learning
Managerial level	Manage AI integration into core service provision processes Manage AI-supported automation systems across functions Monitor AI use across service areas	Guide ethical use of AI systems using policies and standards Manage GDPR and data ethics compliance in AI-supported processes Define accountability for AI use within teams or departments Apply equity, inclusion, and transparency principles to team AI use Assess long-term risks and trust issues related to AI use	Use AI tools aligned with team or service objectives Plan AI strategy and responsible use expectations across departments for staff and partners Train staff in professional development on AI tool use Evaluate scalability and long-term business value of AI solutions Plan investment decisions around AI tools and skills Guide staff in responsible, effective AI use Coordinate partnerships to extend AI capacity

Source: Skills England. (2025, November 04). *AI skills tools package*. Gov.UK. Retrieved 15 December, 2025, from https://www.gov.uk/government/publications/ai-skills-for-the-uk-workforce/ai-skills-tools-package

Taken together, these findings and framework reflect a shared understanding of career-related AI competences. Effective participation in AI-enabled workplaces requires more than technical proficiency alone, and depends equally on transferable non-technical skills such as judgement, adaptability and ethical awareness. These insights inform the proposed Unified AI Literacy Framework by grounding it in how AI is actually used at work and in the realities of continuous reskilling over the life course.

The second recommendation is therefore to include both career-related and contextual competences in the Unified AI Literacy Framework. This is not intended to professionalise AI literacy for all, but to ensure that Singaporeans are equipped to engage with AI meaningfully in work-related contexts while recognising its broader societal and ethical implications. Establishing clear benchmarks for these competences will prepare Singaporeans not only for employment, but also for responsible participation in an AI-augmented society.

Building on these recommendations, the next section translates these principles into a concrete Unified AI Literacy Framework for Singapore. It sets out how foundational digital skills, career-related competences, and contextual competences can be organised into a coherent structure to guide curriculum design, programme development and benchmarking across sectors.

6. TOWARDS A UNIFIED AI LITERACY FRAMEWORK FOR SINGAPORE

This section sets out a proposed Unified AI Literacy Framework for Singapore. The framework is intended as a common reference point, rather than a prescriptive curriculum, to guide policy design, programme development and coordination across sectors. It is designed for the general population, with the expectation that different agencies and providers may emphasise different components depending on audience, context and use case.

The framework is cumulative. Foundational digital access and skills remain prerequisites, while higher-order competences build on earlier ones rather than replacing them. Importantly, the framework does not seek to professionalise AI literacy for all, nor to substitute for governance, regulation, or institutional responsibility. Instead, it clarifies the range of competences individuals can reasonably be expected to develop in an AI-mediated environment.

Figure 4: Proposed Unified AI Literacy Framework for Singapore

Revised outcomes from Unified Framework for Digital Literacy in Singapore

0. **Foundational hardware and software operations, basic decoding skills, AI software use and decoding AI-generated content (to adapt from Unified Framework for Digital Literacy in Singapore and prerequisites of DigComp 3.0)**
    - 0.1. Physical operations of digital technologies
    - 0.2. Basic operations of software such as browsers and turning apps on/off
    - 0.3. Basic operations of AI software such as using prompts
    - 0.4. Basic decoding skills to interpret simple visual, textual and/or audio information generated by AI

1. **Information search, evaluation and management (MOE's EdTech Masterplan 2030) — A basic understanding of the benefits, risks and potential uses of AI**
    - 1.1. Search for information using effective strategies
    - 1.2. Evaluate accuracy, credibility and relevance of information
    - 1.3. Synthesise key ideas from large amount of information online

2. **Safety (adapt from DigComp 3.0 and AI CFS)**
    - 2.1. To protect devices, content, personal data and privacy in AI environments

2.2. Use AI in a responsible manner in compliance with ethical principles and locally applicable regulations

2.3. To be aware of the risks of disclosing data privacy and take measures to ensure that their data are collected, used, shared, archived and deleted only with their deliberate and informed consent

2.4. To be aware of the specific risks of certain AI systems, and are able to protect their own safety, as well as that of their peers, when using AI

2.5. To be aware of the environmental impact of AI technologies and their use, to take action to reduce such impact and to use AI technologies to support sustainability

3. Communication and collaboration (to adapt from DigComp 3.0)

3.1. To interact, share, communicate and collaborate in AI environments while being aware of cultural, generational and other diversity and the features and limitations of AI technologies

3.2. To participate in society through AI

3.3. To assert one's rights and exercise choice in AI environments

3.4. To manage one's digital presence, identity and reputation

4. Digital content creation and computational thinking[10] (to adapt from DigComp 3.0, MOE's EdTech Masterplan 2030, AI CFT and AI Lit)

4.1. To create and edit digital content using AI technologies

4.2. To improve and integrate information and content into an existing body of knowledge while understanding how copyright and licences are to be applied, adopting an ethical and responsible approach in the creation, improvement and integration of digital content

4.3. To know how to apply computational thinking and programming techniques such as such as block-based programming, text-based programming, or prompt engineering, so as to create digital artefacts and develop, test and debug solutions

4.4. Experiment with and customise AI tools across different formats, iteratively refining outputs to create meaningful solutions while reflecting on how the process shapes ideas and decisions

4.5. Collaborate with AI tools to support problem-solving and creativity, while considering ethical implications like ownership and bias

[10] This component is adapted from the "Digital content creation" domain in the Unified Framework for Digital Literacy in Singapore. It has been re-labelled to reflect a broader set of capabilities that go beyond producing online media content, encompassing the use of AI-enabled tools to create, modify and apply digital artefacts, processes or solutions across different contexts.

5. Problem-solving in digital environments (to adapt from DigComp 3.0 and MOE's EdTech Masterplan 2030)

5.1. To identify and assess needs, and to use AI technologies and adapt digital environments to meet these needs

5.2. To identify and resolve technical and conceptual problems and problem situations in digital environments

5.3. To use AI technologies to make improvements in, or new solutions for, processes and products

5.4. To build capabilities to operate autonomously in digital environments

5.5. To stay informed about digital technological developments and the effective use of digital resources

6. Career-related competences (to adapt from Chee et al., 2024)

6.1. Operate specialised AI technologies and interpret, analyse and assess data, information and AI-generated content within a given field

7. [New] Contextual competences (to adapt from Digital Skills Framework and labour market insights)

These contextual capabilities are consistent with widely recognised 21st-century skills framework, but are articulated here specifically in relation to how individuals exercise judgement, agency and responsibility in AI-mediated contexts.

7.1. Problem-solving

7.2. Critical thinking

7.3. Adaptability

7.4. Ethical awareness

7.5. Lifelong learning

8. [New] Ethics (to adapt from DigComp 3.0, AI CFS, AI CFT and AI Lit)

8.1. Demonstrate understanding and habitual application of key ethical principles such as “do no harm”, fairness, transparency, sustainability and human oversight when using AI tools

8.2. Assess the accuracy, reliability and fairness of AI-generated content, recognising potential biases, misinformation or errors; and make informed decisions about whether to trust, modify, or override outputs

8.3. Recognise how AI systems reflect human decisions and data, and identify ways in which bias in design, data, or personal perspectives can lead to unfair outcomes for different individuals or groups.

8.4. Incorporate ethical and legal considerations such as copyright, data protection and the implications of AI use when creating, evaluating, or sharing AI-generated information

7. IMPLEMENTATION CONSIDERATIONS AND ILLUSTRATIVE EXAMPLES

This section illustrates how the proposed Unified AI Literacy Framework can be operationalised by mapping it against selected internationally recognised AI literacy programmes. The illustrative examples are not endorsements or intended to be exhaustive. Rather, they are used to demonstrate how different components of the framework are currently emphasised or operationalised in existing training offerings, and to surface gaps that a national reference framework can help address.

7.1. Certiport Generative AI Foundations Certification

Certiport's Generative AI Foundations certification provides learners with a fundamental understanding of generative AI, its applications in both personal and professional contexts, and the responsible and ethical use of the technology. This certification is designed for complete beginners and covers the following skills (see Table 9).

Table 9: Certiport Competences

Category	Skillset
Generative AI methods and methodologies	• Define generative AI • Explain the basic processes generative AI uses to produce an output • Recognise the input and output types used in a

	generative AI scenario • Recognise that generative AI models can be customised to perform individualised tasks • Select an appropriate tool to perform a specific task • Describe the limitations of generative AI
Basic prompt engineering	• Identify appropriate prompts to elicit textual information • Identify appropriate prompts to transform content • Identify appropriate prompts to elicit image creation and transformation • Identify appropriate prompts to elicit video creation and transformation
Prompt refinement	• Given an initial prompt and its output, evaluate how the prompt can be improved to elicit more targeted output • Given an initial prompt and its output, identify additional inputs you can use to elicit more targeted output • Recognise common prompting techniques • Use reverse prompting techniques to achieve an outcome • Given an AI output, explain how you can verify the accuracy of the output
Ethics, law and societal impact	• Identify the potential for bias in generative AI output • Identify the potential legal implications of using generative AI • Explain the importance of data privacy • Determine the risks associated with using generative AI • Identify the impacts of generative AI on society

Source: Certiport. (n.d.). *Generative AI Foundations*. https://certiport.filecamp.com/s/i/ANWO7jCo2RXMkYFp

The Certiport certification demonstrates the broadest alignment with the proposed Unified AI Literacy Framework, spanning foundational AI knowledge, information literacy, safety, digital content creation and ethics. However, it places less

emphasis on communication, problem-solving, career competences and broader contextual capabilities.

7.2. ICDL Artificial Intelligence Module

The artificial intelligence module is offered by the International Computer Driving License (ICDL) Foundation. This module is part of ICDL's Professional programme, which supports professionals across multiple sectors by enabling learners to build advanced skills for technology-reliant roles (International Computer Driving License Foundation, n.d.-a). The module is suitable for a broad range of learners, including non-technical professionals and students (see Table 10 for learning outcomes).

Table 10: ICDL AI Module Learning Outcomes

Category	Learning outcomes
What is artificial intelligence (AI)?	• Define AI • Recognise three stages of AI: narrow, general, super • Recognise key milestones in the development of AI
How does AI work?	• Identify key principles underpinning AI: algorithms, complexity, heuristics • Define machine learning and identify its key characteristics • Define neural network and identify its key characteristics • Define deep learning and identify its key characteristics

Common AI examples	• Identify the need for AI in organisations and society • Recognise common examples of how AI supports data mining • Recognise common examples of how AI supports image recognition • Recognise common examples of how AI supports natural language processing • Recognise examples of how AI supports decision making
AI adoption: challenges and potential	• Recognise limits to AI • Recognise ethical guidelines that should inform the operation of AI: clarity and desirability of purpose, transparency, competence in operations • Social and economic impact of AI • Potential and implications of AI for different sectors • Implications of adopting AI in a given scenario

Source: International Computer Driving License Foundation. (n.d.-b). *ICDL Professional: Artificial Intelligence*. https://icdl.org/wp-content/uploads/ICDL-Artificial-Intelligence-Syllabus-1.0-1.pdf

Overall, the ICDL Artificial Intelligence module aligns primarily with the ethics and safety-related components of the proposed Unified AI Literacy Framework, but places limited emphasis on applied workplace use, communication and collaboration, or career-specific AI competences.

7.3. Microsoft AI Fluency Learning Path

Microsoft AI Fluency offers a complete learning pathway that equips individuals with essential AI knowledge and skills. Each module is tailored to help individuals and organisations apply AI technologies to their specific contexts and needs (Microsoft, n.d.). See Table 11 for an overview of each module and its corresponding learning objectives.

Table 11: Microsoft AI Fluency Modules and Learning Objectives

Modules	Learning objectives
Explore AI basics	• Evaluate the concepts of AI, machine learning and deep learning by comparing their definitions, applications and interconnections • Evaluate the effectiveness of different AI algorithms in solving specific real-world problems by accurately identifying and justifying the most appropriate algorithm for a given scenario • Assess the historical milestones in the development of AI and determine which milestone most significantly contributed to the practical applications of AI in everyday life
Explore generative AI	• Distinguish between Natural Language Processing (NLP), Natural Language Generation (NLG) and Large Language Models (LLMs), assessing their roles, applications and interrelationships with generating human language • Assess the differences between generative AI and traditional AI models, focusing on their applications, capabilities and the role of data • Evaluate how generative AI services like Microsoft Copilot can enhance creativity in various fields
Explore internet search and beyond	• Evaluate the differences between a search engine and a reasoning engine by comparing their functionalities, underlying technologies and applications • Assess the effectiveness of the crawling, indexing and ranking processes in search engines, and understand how these processes contribute to the retrieval of relevant search results • Assess the importance of prompt engineering by evaluating the effectiveness of various prompts, critiquing best practices in prompting, and determining how critical thinking plays a crucial part

Explore responsible AI	• Evaluate the ethical implications in AI by critically analysing AI-generated content and cross-verifying information from multiple sources • Assess the ethical and security concerns associated with deepfakes, including their potential misuse in spreading misinformation and impersonation • Evaluate the global human-AI interactions by analysing key factors such as data privacy, algorithmic bias, transparency and legal liability
Get started with Microsoft Copilot	• Critically assess the main functions and benefits of Copilot at enhancing productivity and creativity • Identify and apply specific strategies to interact with Copilot effectively, ensuring productive and meaningful conversations by providing detailed prompts and feedback • Explain the fundamental aspects of GPT models, including their architecture and capabilities, and how these features enable the generation of human-like text
Boost your productivity with Microsoft Copilot	• Evaluate the effectiveness of Copilot in supporting skill development and career advancement • Use Copilot to optimise personal and professional schedules, draft messages and emails, plan projects and manage time • Evaluate the effectiveness of the retrieval-augmented generation method of Copilot in providing relevant and up-to-date information for your questions
Explore AI for all	• Assess how AI initiatives are enhancing accessibility for individuals with disabilities • Evaluate the impact of AI on various job roles by analysing specific examples from different sectors such as finance, healthcare, energy, manufacturing, retail, public sector and agriculture

	• Evaluate the effectiveness of AI-driven solutions in enhancing humanitarian action by analysing case studies and real-world applications

Adapted from: Microsoft. (n.d.). *AI Fluency*. https://learn.microsoft.com/en-us/training/paths/ai-fluency/

Microsoft AI Fluency aligns strongly with information management, digital content creation and ethical components of the proposed unified framework. However, it places less emphasis on foundational skills, safety, problem-solving, career-related competences and contextual capabilities.

Table 12 presents an overview of how different components of the unified framework are currently operationalised by existing training offerings.

Table 12: Operationalisation of Unified AI Literacy Framework

Competences	Description	Operationalisation (based on illustrative examples)	Enterprise programmes
0. Foundational hardware and AI software operations, basic decoding skills	0.1. Physical operations of digital technologies 0.2. Basic operations of software such as browsers and turning apps on/off 0.3. Basic operations of AI software such as using prompts 0.4. Basic decoding skills to interpret simple visual, textual and/or audio information generated by AI	• Identify appropriate prompts to elicit textual information • Identify appropriate prompts to transform content • Identify appropriate prompts to elicit image creation and transformation • Identify appropriate prompts to elicit video creation and transformation, and interconnections • Recognise common prompting techniques	Certiport
1. Information search, evaluation and management	1.1. Search for information using effective strategies 1.2. Evaluate accuracy, credibility and relevance of information 1.3. Synthesise key ideas from large amount of information online	• Evaluate the concepts of AI, machine learning and deep learning by comparing their definitions, applications and interconnections • Evaluate the effectiveness of different AI algorithms in solving specific real-world problems by accurately identifying and justifying the most appropriate algorithm for a given scenario • Assess the historical milestones in the development of AI and determine which	Microsoft AI Fluency

		milestone most significantly contributed to the practical applications of AI in everyday life • Distinguish between Natural Language Processing (NLP), Natural Language Generation (NLG) and Large Language Models (LLMs), assessing their roles, applications, and interrelationships with generating human language • Assess the differences between generative AI and traditional AI models, focusing on their applications, capabilities and the role of data • Evaluate how generative AI services like Microsoft Copilot can enhance creativity in various fields • Given an AI output, explain how you can verify the accuracy of the output	Certiport
2. Safety	2.1. To protect, devices, content, personal data and privacy in AI environments 2.2. Use AI in a responsible manner in compliance with ethical principles and locally applicable regulations 2.3. To be aware of the risks of disclosing data privacy and take measures to ensure that their	• Identify the potential legal implications of using generative AI • Explain the importance of data privacy • Determine the risks associated with using generative AI • Identify the impacts of generative AI on society • Recognise limits to AI • Recognise ethical guidelines that should inform the operation of AI: clarity and desirability of	Certiport ICDL

	data are collected, used, shared, archived and deleted only with their deliberate and informed consent 2.4. To be aware of the specific risks of certain AI systems, and are able to protect their own safety as well as that of their peers when using AI 2.5. To be aware of the environmental impact of AI technologies and their use, to take action to reduce such impact, and to use AI technologies to support sustainability	purpose, transparency, competence in operations • Social and economic impact of AI • Potential and implications of AI for different sectors • Implications of adopting AI in a given scenario	
3. Communication and collaboration	3.1. To interact, share, communicate and collaborate in AI environments while being aware of cultural, generational and other diversity and the features and limitations of AI technologies 3.2. To participate in society through AI		

	3.3. To assert one's rights and exercise choice in AI environments 3.4. To manage one's digital presence, identity and reputation		
4. Digital content creation and computational thinking	4.1. To create and edit digital content using AI technologies 4.2. To improve and integrate information and content into an existing body of knowledge while understanding how copyright and licences are to be applied, adopting an ethical and responsible approach in the creation, improvement and integration of digital content 4.3. To know how to apply computational thinking and programming techniques such as such as block-based programming, text-based programming, or prompt engineering, to create digital artefacts and develop, test and debug solutions	• Identify appropriate prompts to elicit textual information • Identify appropriate prompts to transform content • Identify appropriate prompts to elicit image creation and transformation • Identify appropriate prompts to elicit video creation and transformation • Explain the basic processes generative AI uses to produce an output • Recognise the input and output types used in a generative AI scenario • Recognise that generative AI models can be customised to perform individualised tasks • Select an appropriate tool to perform a specific task • Given an initial prompt and its output, evaluate how the prompt can be improved to elicit more	Certiport

	4.4. Experiment with and customise AI tools across different formats, iteratively refining outputs to create meaningful solutions while reflecting on how the process shapes ideas and decisions 4.5. Collaborate with AI tools to support problem-solving and creativity, while considering ethical implications like ownership and bias	targeted output • Given an initial prompt and its output, identify additional inputs you can use to elicit more targeted output • Evaluate the differences between a search engine and a reasoning engine by comparing their functionalities, underlying technologies and applications • Assess the effectiveness of the crawling, indexing and ranking processes in search engines, and understand how these processes contribute to the retrieval of relevant search results • Assess the importance of prompt engineering by evaluating the effectiveness of various prompts, critiquing best practices in prompting and determining how critical thinking plays a crucial part	Microsoft AI Fluency
5. Problem-solving in digital environments	5.1. To identify and assess needs, and to use AI technologies and adapt digital environments to meet these needs 5.2. To identify and resolve technical and conceptual problems and problem situations in digital environments		

	5.3. To use AI technologies to make improvements in or create new solutions for processes and products 5.4. To build capabilities to operate autonomously in digital environments 5.5. To stay informed about digital technological developments and the effective use of digital resources		
6. Career-related competences	6.1. Operate specialised AI technologies and interpret, analyse and assess data, information and AI-generated content within a given field		
7. [New] Contextual competences	7.1. Problem-solving 7.2. Critical thinking 7.3. Adaptability 7.4. Ethical awareness 7.5. Lifelong learning		
8. [New] Ethics	8.1. Demonstrate understanding and habitual application of key ethical principles such as “do no harm”, fairness, transparency,	• Evaluate the ethical implications in AI by critically analysing AI-generated content and cross-verifying information from multiple sources	Microsoft AI Fluency

	sustainability and human oversight when using AI tools 8.2. Assess the accuracy, reliability and fairness of AI-generated content, recognising potential biases, misinformation or errors, and make informed decisions about whether to trust, modify or override outputs 8.3. Recognise how AI systems reflect human decisions and data, and identify ways in which bias in design, data or personal perspectives can lead to unfair outcomes for different individuals or groups 8.4. Incorporate ethical and legal considerations such as copyright, data protection, and the implications of AI use when creating, evaluating or sharing AI-generated information	• Assess the ethical and security concerns associated with deepfakes, including their potential misuse in spreading misinformation and impersonation • Evaluate the global human-AI interactions by analysing key factors such as data privacy, algorithmic bias, transparency and legal liability • Recognise ethical guidelines that should inform the operation of AI: clarity and desirability of purpose, transparency, competence in operations • Identify the potential for bias in generative AI output	ICDL Certiport

8. CONCLUSION

The rapid integration of AI into everyday environments, learning systems and workplaces is reshaping economic participation and learning opportunities. At the same time, it is reconfiguring existing digital inequalities at an accelerated pace, often in ways that are less visible but more consequential. The resulting "AI divide" reflects not only differences in access to AI tools, but uneven exposure to AI-enabled risks, disparities in individuals' capacities to adapt and exercise judgement, and divergent outcomes across education and employment.

Against this backdrop, Singapore's extensive yet fragmented landscape of AI-related initiatives reflects strong national commitment alongside identifiable structural constraints. While current programmes have made meaningful progress in areas such as information literacy and safety, other dimensions—including communication and collaboration, content creation, problem-solving and workplace application—remain unevenly developed. In the absence of a shared reference framework, these differences risk producing inconsistent learning outcomes and uneven preparedness across the population.

The Unified AI Literacy Framework proposed in this paper seeks to address these gaps by providing a coherent reference point that integrates foundational digital skills, career-related competences and contextual capabilities such as judgement, adaptability and ethical awareness. This integrated approach reflects the reality that effective engagement with AI depends not only on

technical proficiency, but on the ability to make informed decisions about when, how and whether AI should be used in specific contexts.

At the same time, AI literacy should not be treated as a substitute for governance, regulation or institutional responsibility; nor should the framework be regarded as fixed or exhaustive. As AI technologies, applications and associated risks continue to evolve, the competences required to engage with them will necessarily change. Ongoing review and adaptation are therefore essential if AI literacy efforts are to remain relevant, credible and responsive to changing societal needs.

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APPENDICES

Appendix A: DigComp 3.0

Competence 1: Information search, evaluation and management		
Competence	**Proficiency level**	**Content covered**
Browsing, searching and filtering information	Basic	• Acknowledge the benefits of using different digital search tools and methods, depending on one's purpose. [AI-I][11] • Identify the main features of commonly-used AI-driven and traditional search tools. [AI-E][12] • Recognise that digital search results or outputs can contain information that may not be relevant, and that they depend on the digital search tool used and the way that an individual specifies the search. [AI-I] • Use digital search tools to implement, refine and update basic information searches. [AI-I]
	Intermediate	• Purposefully explore new digital search tools and strategies. [AI-I] • Select appropriate digital search tools based on information needs. [AI-I] • Distinguish between more and less relevant digital search results or outputs. [AI-I] • Translate information needs into effective digital search queries, commands or statements, and apply appropriate strategies to refine or filter results. [AI-I]

[11] AI-implicit or [AI-I] applies to competences for one or more of four reasons. The competence statement or learning outcome could: (1) Involve the use of AI systems as one of several available digital technologies, (2) Involve the use of a digital technology that has AI system functionality embedded in it, (3) Relate to an understanding of how AI systems operate, and (4) Relate to personal, ethical or societal implications of AI systems (Cosgrove & Cachia, 2025).
[12] AI-explicit or [AI-E] means that AI systems are explicitly relevant to that competence (Cosgrove & Cachia, 2025).

Competence 1: Information search, evaluation and management		
Competence	**Proficiency level**	**Content covered**
Evaluating information	Basic	• Acknowledge the benefits of a cautious approach in interpreting information and content in digital environments. [AI-I] • Recognise that some digital information sources and systems may not be trustworthy. [AI-I] • Recognise that it can be difficult to distinguish between information and content generated by humans and AI systems. [AI-E] • Recognise examples of misinformation, disinformation and sources of bias. [AI-I] • Recognise examples of social media influencing and filter bubbles. [AI-I] • Make a basic assessment of the reliability and credibility of digital information sources and content. [AI-I]
	Intermediate	• Identify the source of online information and the purposes of fact-checking services to develop pre-bunking and de-bunking capabilities. [AI-I] • Recognise that the data used to train AI systems and how they are trained affects the reliability of the information they provide. [AI-E] • Recognise that some digital technologies, such as AI systems, might function like a 'black box', making it difficult to explain why or how an output has been produced. [AI-E] • Recognise that AI systems may produce output which is inaccurate, even if it may seem plausible, and that the human using the AI system is responsible for checking the quality and validity of information and content generated. [AI-E] • Recognise that individual (cognitive and affective) biases and AI system biases play a role in the generation and interpretation of information. [AI-E] • Recognise and respond effectively to user-directing strategies in digital environments such as clickbait, nudging and gamification. [AI-I]

		• Critically assess the reliability of sources, information and content in digital environments, considering the role of AI systems, personalisation effects, and commercial or other interests. [AI-E]

Competence 1: Information search, evaluation and management		
Competence	**Proficiency level**	**Content covered**
Managing information	Basic	• Acknowledge the benefits of managing and organising information in digital environments. • Recognise functions of data removal, restoration and backup, and main properties of digital files and folders. • Download, save, retrieve, move and delete digital files. • Organise and format simple data in a structured digital environment, such as in spreadsheets. • Update one's contacts, such as on phone, email or social media
	Intermediate	• Acknowledge the importance of careful and ethical management of data and information in digital environments. [AI-I] • Apply naming conventions to digital files and hierarchies to digital folders. • Organise folders, and manage, save and delete files on digital devices, external storage and cloud services. • Identify common types of data and their formats, and use data collection tools for simple processing of data. [AI-I] • Manage information in one's digital accounts, such as email. [AI-I] • Organise and format data and apply basic formulas in a structured digital environment, such as in spreadsheets

Competence 2: Communication and Collaboration		
Competence	**Proficiency level**	**Content covered**
Interacting through and with digital technologies	Basic	• Identify and use basic features of digital communication tools to interact with individuals and groups. [AI-I] • Acknowledge the importance of taking others' preferences into account in digital communication. • Recognise differences between digital and non-digital interactions, and between physical and virtual realities. [AI-I] • Identify basic features of virtual assistants (chatbots) and recognise key differences between human-to-machine and human-to-human interactions. [AI-I] • Recognise in general terms what a robot is, the non-human nature of robots, and that humans interact with robots to carry out tasks. [AI-I]
	Intermediate	• Acknowledge the importance of tailoring one's digital communication to specific contexts. • Recognise that there is a reality-virtuality continuum in digital environments. [AI-I] • Identify a suitable communication means for a given context or purpose. [AI-I] • Use multiple features of a variety of digital communication tools to interact with and manage individuals, groups and channels. [AI-I] • Develop and refine questions, commands or statements (prompts) for virtual assistants (chatbots) and AI systems to handle non-complex interactions. [AI-E] • Define how humans can interact with robots, identifying their key features (such as sensors, software, motion controls and human interface), and recognising that they can operate with varying degrees of autonomy. [AI-I]

Competence 2: Communication and Collaboration		
Competence	**Proficiency level**	**Content covered**
Sharing through digital technologies	Basic	• Acknowledge the importance of ethical and responsible sharing of information and content. [AI-I] • Identify functions and uses of social media, and examples of common social media platforms. [AI-I] • Recognise benefits and risks of sharing information and content in digital environments, and that individuals can choose how and what to share. [AI-I] • Recognise that content can be shared in a variety of ways by AI systems as well as humans. [AI-E] • Identify purpose and target audience of information and content to be shared in digital environments. • Use simple processes to share information and content in digital environments appropriately and in accordance with goals.
	Intermediate	• Acknowledge the importance of assessing the value and accuracy of information and content prior to sharing it in digital environments. • Define responsibilities associated with sharing information and content in digital environments. [AI-I] • Describe and implement effective and ethical ways to share information and content in a variety of digital environments. [AI-I] • Report or flag misinformation and disinformation that has been shared in digital environments. [AI-I]

Competence 2: Communication and Collaboration		
Competence	**Proficiency level**	**Content covered**
Engaging in citizenship through digital technologies	Basic	• Identify main purposes and functions of digital platforms and services, using them with assistance as needed. [AI-I] • Recognise the potential of digital technologies for participation and empowerment — and exclusion — of oneself and specific groups and communities. [AI-I] • Recognise that there are laws and regulations to protect the rights of users of digital platforms and services. [AI-I] • Use digital tools to search for and find communities for civic participation on issues of interest. [AI-I]
	Intermediate	• Participate in discussions on digital citizenship topics. [AI-I] • Prioritise the exploration of ways that digital technologies can enhance one's civic and societal participation. [AI-I] • Describe the potential benefits of common forms of digital participation, recognising that civic participation occurs along a continuum. • Recognise key rights under relevant digital laws and regulations, and define how to exercise them. [AI-I] • Describe how digital technologies such as social media platforms can influence some aspects of basic democracy (for example, distortion of the electoral process). [AI-I] • Describe the concept of the platform economy, including opportunities, risks, social and ethical implications. [AI-I] • Describe the concepts and functions of civic monitoring and e-Government. • Interact autonomously and effectively with digital platforms and services. [AI-I]

Competence 2: Communication and Collaboration		
Competence	**Proficiency level**	**Content covered**
Collaborating through digital technologies	Basic	• Participate in collaborative groups via digital collaboration tools, recognising their benefits and limitations. [AI-I] • Recognise the presence of AI systems in digital collaboration tools. [AI-E] • Acknowledge the importance of effective communication skills for successful collaboration in digital environments.
	Intermediate	• Create, manage and contribute effectively to simple collaborative tasks in digital environments. [AI-I] • Recognise main features and functions of a variety of collaboration tools, selecting them to meet collaboration goals. [AI-I] • Identify examples of ethical, responsible and effective human-AI collaboration. [AI-E] • Take account of different perspectives to help achieve a common goal in digital environments

Competence 2: Communication and Collaboration		
Competence	**Proficiency level**	**Content covered**
Digital behaviour	Basic	• Recognise differences in verbal and non-verbal behaviour in digital and non-digital environments, and that there are cultural and contextual differences in verbal and non-verbal digital communication. • Acknowledge the importance of giving space to the opinions of others in digital environments. • Recognise that some behaviour in digital environments may not be acceptable to others, and/or may have legal consequences. [AI-I] • Use appropriate tone and visual expression such as emoji in formal and non-formal digital environments.
	Intermediate	• Describe the relationship between digital behaviour and digital reputation. • Prioritise behaviour that supports inclusion and a positive digital reputation for oneself and others. • Identify key rights and responsibilities of children and adults in relation to digital behaviour. [AI-I]

Competence 2: Communication and Collaboration		
Competence	**Proficiency level**	**Content covered**
Managing digital identity	Basic	• Acknowledge the benefits of implementing measures to help manage one's digital identity. • Recognise features of physical and digital identities, and identify aspects of physical identity that can be linked to digital identity. • Recognise digital identity as both a means of authenticating (validating) an individual and the data generated by an individual's online activities, and identify common forms and uses of digital identity. [AI-I] • Recognise the concept and components of a digital footprint. [AI-I] • Recognise that digital identity protection laws protect individuals' data and privacy. [AI-I] • Identify and implement simple measures, such as limiting tracking and deleting browsing history, to manage digital identity.
	Intermediate	• Acknowledge the importance of one's own role and rights in the management of digital identity. [AI-I] • Identify examples of actively and passively generated information in relation to digital identity. [AI-I] • Analyse the scope of one's own digital identity to implement protections. [AI-I] • Adjust settings on devices and apps, online accounts and activity tracking to help manage one's digital identity. [AI-I] • Curate and manage one or more digital identities using a variety of features and functionalities on digital platforms or services. [AI-I]

Competence 3: Content Creation		
Competence	**Proficiency level**	**Content covered**
Developing digital content	Basic	• Acknowledge the benefits of exploring a variety of digital content creation tools to support content creation goals. [AI-I] • Acknowledge the importance of accessible and inclusive digital content. • Identify common types of digital content and file formats, and common operational functions across digital content creation tools. [AI-I] • Recognise that while AI systems can generate content, humans are essential to ensure ethical, responsible and context-appropriate outputs. [AI-E] • Recognise that generative AI is a particular type of AI and is one of various digital technologies that can be used to support content creation. [AI-E] • Use basic features of content creation tools to create and edit digital content. [AI-I]
	Intermediate	• Purposefully explore features and functions of digital content creation tools to deepen capabilities. [AI-I] • Describe benefits and limitations in the use of digital technologies such as AI systems for content creation, using them selectively and ethically. [AI-E] • Use a variety of content creation tools to create and edit digital content. [AI-I] • Apply strategies that enable efficient digital content creation. [AI-I] • Assess audience accessibility and inclusivity needs, and create and edit digital content accordingly. [AI-I]

Competence 3: Content Creation		
Competence	**Proficiency level**	**Content covered**
Integrating and re-elaborating digital content	Basic	• Acknowledge the importance of ethical and transparent practices when re-using or elaborating existing digital content. [AI-I] • Acknowledge the benefits of exploring digital content integration and elaboration tools and techniques. [AI-I] • Distinguish between editable and uneditable digital content. • Make changes to digital content using basic editing, formatting and integration functions. [AI-I]
	Intermediate	• Purposefully explore a variety of ways to integrate and re-elaborate digital content. [AI-I] • Adjust or integrate digital content to meet format, structure and audience requirements. [AI-I] • Modify or transform digital textual, numeric or visual representations to effectively and accurately convey the meaning of data and information. [AI-I] • Use digital technologies in a selective, ethical, transparent and responsible way to make enhancements or integrations to existing digital content. [AI-I]

Competence 3: Content Creation		
Competence	**Proficiency level**	**Content covered**
Copyright and licenses	Basic	• Recognise the general concepts of copyright and licence in digital contexts, and that an individual's original digital content is automatically copyrighted. • Recognise that copyright and licences can apply to digital content, including AI-generated content, and that these determine how content can be used and shared. [AI-E] • Recognise that AI-generated content should be labelled as such to help others understand its origin and possibilities for further use. [AI-E] • Use and share digital content in compliance with basic legal and ethical guidelines, and identify digital content that can be used free of charge. [AI-I]
	Intermediate	• Acknowledge the complexity of copyright and licences in digital contexts, prioritising a cautious approach. [AI-I] • Define the concept of intellectual property, and distinguish between copyright, trademark, design and patent. [AI-I] • Identify common types and purposes of licences in digital contexts, including Creative Commons. • Describe ethical, legal and commercial implications of copyright violations in digital contexts. [AI-I] • Identify examples of legal and ethical challenges relating to copyright in the training of AI models. [AI-E] • Apply legal and ethical guidelines appropriately when using and sharing digital content. [AI-I]

Competence 3: Content Creation		
Competence	**Proficiency level**	**Content covered**
Computational thinking and programming	Basic	• Recognise the role of programming in society, and common uses of computer programs and applications. • Recognise computational thinking as a human activity which involves the identification of steps that can be performed by a computer to solve a problem or task. • Recognise what AI is in general terms, making a basic distinction between what is and what is not an AI system. [AI-E] • Represent simple sequences symbolically, interpret simple symbolic sequences, and give basic instructions to a computer to perform simple tasks. [AI-I]
	Intermediate	• Acknowledge the relevance of computational thinking, algorithmic representation and programming to everyday contexts. [AI-I] • Distinguish between a computational model of reality and reality itself. [AI-I] • Define differences between a computable problem and a non-computable problem, and general steps in computational thinking. • Define foundational programming concepts and recognise that there are a variety of programming languages, each with a range of potential uses. [AI-I] • Recognise that machine learning is a type of programming used in AI that enables algorithms to learn from data and make predictions. [AI-E] • Recognise that there are steps that should be followed to develop, validate and deploy a computer program or an AI system. [AI-E] • Translate basic information into logical operations, develop basic programmes with control structures, and create visual representations to illustrate basic algorithms. [AI-I]

Competence 4: Safety, wellbeing and responsible use		
Competence	**Proficiency level**	**Content covered**
Protecting devices	Basic	• Acknowledge the importance of one's individual role in protecting digital devices and their contents. • Recognise that individual actions and cybersecurity tools work together to help keep devices and their contents secure. • Recognise that there is cybersecurity legislation that helps to ensure the security of products and services. • Identify and apply basic device protection measures such as antivirus software, screen locking, strong passwords and multi-factor authentication
	Intermediate	• Acknowledge the importance of remaining vigilant to and up-to-date with cybersecurity practices. [AI-I] • Describe main features of malware and apply a variety of malware prevention techniques to protect devices and their contents. [AI-I] • Recognise that recent and emerging digital technologies such as AI systems can be used for both cyberattacks and cybersecurity. [AI-E]

Competence 4: Safety, wellbeing and responsible use		
Competence	**Proficiency level**	**Content covered**
Protecting personal data and privacy	Basic	• Acknowledge the importance of a cautious approach to the sharing of personal data in digital environments. • Recognise that personal data is collected and generated through a large variety of sources and processes. [AI-I] • Recognise that manipulative methods can be used in digital environments to deceive individuals into providing access to personal data, accounts or other sensitive information. • Identify risks of sharing personal data in digital environments, including specific risks in relation to AI systems. [AI-E] • Recognise that individuals have a right to privacy and that their personal data is protected under legislation. [AI-I] • Implement basic security measures for online payments and transactions. • Block or flag personal information that has been inappropriately shared online. • Recognise and respond appropriately to signs of identity theft
	Intermediate	• Recognise the importance of careful handling of personal data of oneself and others, especially vulnerable individuals and children. • Recognise key concepts related to data protection and privacy legislation. [AI-I] • Define the purpose of online privacy statements and main privacy policy concepts. • Define personal data breach under current data protection and privacy legislation. • Describe privacy implications associated with the use of shared online content, such as to train AI systems, recognising that regulation of personal data ownership of content shared online is complex. [AI-E] • Describe techniques related to social engineering in digital environments, such as phishing or

		baiting, identifying and responding appropriately to instances of them. • Safely manage personal data and privacy across a variety of digital environments, including use of privacy tools. [AI-I]

Competence 4: Safety, wellbeing and responsible use		
Competence	**Proficiency level**	**Content covered**
Supporting wellbeing	Basic	• Acknowledge the benefits of balancing online and offline activities, and the benefits and risks to one's own physical, mental and social wellbeing in using digital technologies. [AI-I] • Acknowledge the interplay between one's own digital habits and features of digital platforms or services that are designed to capture and maintain users' attention. [AI-I] • Recognise that there is a variety of information, groups and communities in digital environments that can support one's physical, mental and/or social wellbeing. [AI-I] • Identify limitations and risks of using virtual assistants and AI systems to support human wellbeing. [AI-E] • Recognise that there are laws and regulations that help protect the wellbeing of individuals in digital environments. [AI-I] • Make a basic assessment of one's digital habits in relation to one's physical, mental and social wellbeing, with an awareness of signs of problematic usage, and identify and implement strategies to support one's wellbeing.
	Intermediate	• Acknowledge the importance of one's own and others' right to disconnect and the benefits of regularly reviewing one's digital usage patterns. • Describe impacts of harmful behaviour, content and deceptive design in digital environments on oneself and others. [AI-I] • Identify reliable sources of information, and inclusive groups and communities in digital environments, that can support one's physical, mental and/or social wellbeing. [AI-I]

		• Identify possible ways to flag or intervene if harmful behaviour or content is encountered in digital environments. [AI-I] • Describe ways in which some digital technologies, such as social media, augment and perpetuate bias, stereotyping and exclusion. [AI-I] • Implement strategies to protect against and respond effectively to harmful behaviour, content and deceptive design in digital environments, and to support and maintain one's own and others' wellbeing. • Adapt to changing digital technological developments and needs to support and maintain physical, mental and social wellbeing. [AI-I]

Competence 4: Safety, wellbeing and responsible use		
Competence	**Proficiency level**	**Content covered**
Environmental impacts of digital technologies	Basic	• Acknowledge the role that individuals can play to help reduce the environmental impact of digital technologies. • Recognise that some digital technologies and infrastructures, such as AI systems and data centres, have large impacts on the environment. [AI-E] • Recognise that the full environmental impacts of digital technologies are not immediately apparent to an individual user. [AI-I] • Recognise the role of digital technologies in supporting energy efficiency and sustainability. [AI-I] • Identify and apply simple strategies to reduce energy and data consumption while using digital technologies. [AI-I]
	Intermediate	• Continually assess the environmental impacts of one's usage of digital technologies. [AI-I] • Identify environmental impacts of digital technologies that occur during manufacturing, usage and disposal, and of data centres and e-commerce. [AI-I] • Describe how some digital technologies can support sustainable living. [AI-I] • Describe potential environmental benefits of the digital sharing and circular economy models. • Assess and apply a variety of strategies to reduce the environmental impact of one's use of digital technologies and digital devices. [AI-I]

Competence 5: Problem identification and solving		
Competence	**Proficiency level**	**Content covered**
Identifying and solving technical problems	Basic	• Acknowledge the commonplace nature of technical problems in digital environments and the benefits of seeking assistance to help resolve them. • Differentiate between operating systems and software and identify the main features of hardware, software, connectivity and common peripheral devices. • Identify common technical issues and follow instructions to help to solve them. • Install and update software and applications, as needed.
	Intermediate	• Acknowledge the benefits of building capacity and autonomy in addressing common technical issues. • Troubleshoot technical problems in digital environments using a variety of search and problem-solving strategies (whether human-assisted or digital technology-assisted). [AI-I] • Update and adjust settings on main and peripheral digital devices to maintain good performance.

Competence 5: Problem identification and solving		
Competence	**Proficiency level**	**Content covered**
Identifying needs and digital technological responses	Basic	• Acknowledge the importance of individual choice in digital environment configurations. • Recognise the concept and purpose of a digital assistance tool and the presence of AI systems in such tools. [AI-E] • Identify the purpose of technology accessibility and examples of common assistive technologies. [AI-I]
	Intermediate	• Acknowledge the benefits of exploring adaptations to digital environment configurations and features of digital assistance tools. [AI-I] • Make informed use of digital assistance tools to support one's own and others' needs, with awareness of their benefits and limitations. [AI-I] • Adjust features of one's digital environment to suit one's own and others' needs and preferences. [AI-I]

Competence 5: Problem identification and solving		
Competence	**Proficiency level**	**Content covered**
Identifying creative solutions using digital technologies	Basic	• Recognise that digital technologies can support, but not replace, human creativity. [AI-I] • Identify examples of how digital technologies are used to solve real-world problems and to make improvements to or create new solutions, products or services. [AI-I] • Identify examples of where digital technologies can support or augment human creativity. [AI-I]
	Intermediate	• Define the concept of human-centric and its role in digital technologies development and usage. [AI-I] • Describe strengths, weaknesses and ethical considerations of digital technologies including AI systems in relation to human creativity and problem-solving. [AI-E] • Use a variety of digital technologies responsibly and ethically to support problem-solving as an individual or in a group. [AI-I]

Competence 5: Problem identification and solving		
Competence	**Proficiency level**	**Content covered**
Identifying and addressing digital competence needs	Basic	• Acknowledge the value of developing one's digital competence, and the benefits of seeking support in addressing digital competence needs. [AI-I] • Recognise that digital competence is much broader than technical skills, and requires regular updating for daily life, working and learning. [AI-I] • Identify opportunities to improve one's digital competences. [AI-I]
	Intermediate	• Acknowledge the benefits of staying informed about developments in digital technologies to help identify learning needs. [AI-I] • Accurately assess one's own digital competences and digital competence needs. [AI-I] • Participate actively in learning to meet one's digital competence needs. [AI-I]

Adapted from: Cosgrove, J. & Cachia, R. (2025). *DigComp 3.0: European Digital Competence Framework - Fifth Edition*. European Commission. https://data.europa.eu/doi/10.2760/0001149

Appendix B: AI CFS — Competency Aspects, Blocks, Skills and Values

Competency aspects	Competency blocks	Skills and values
Human-centred mindset	Human agency	• Recognise that AI is human-led and that the decisions of AI creators influence the way in which AI systems impact human rights, human–AI interaction, as well as their own lives and societies • Understand the implications of protecting human agency throughout the design, provision and use of AI
	Human accountability	• Recognise that human accountabilities are the legal obligations of AI creators and AI service providers • Understand what human accountabilities they should assume during the design and use of AI • Develop an awareness that human accountability is a legal and social responsibility when using AI to assist in decision-making and that human choice should not be ceded to AI when making high-stakes decisions
	Citizenship in the AI era	• Critically understand the impact of AI on human societies • Promote responsible and inclusive design and use of AI for sustainable awareness • Develop desire to continue learning about, and using AI throughout their lives to support self-actualisation
Ethics of AI	Embodied ethics	• Develop a basic understanding of the issues underlying key ethical debates around AI • Understand, internalise and adopt the following principles in their

		reflective practices and uses of AI tools in their learning and beyond: ○ Do no harm ○ Proportionality ○ Non-discrimination ○ Sustainability ○ Human determination in human-AI collaboration ○ Transparency and explainability
	Safe and responsible use	• Use AI in a responsible manner in compliance with ethical principles and locally applicable regulations • Aware of the risks of disclosing data privacy and take measures to ensure that their data are collected, used, shared, archived and deleted only with their deliberate and informed consent • Aware of the specific risks of certain AI systems, and are able to protect their own safety, as well as that of their peers, when using AI
	Ethics by design	• Adopt an ethics-by-design approach to the design, assessment and use of AI tools and review and adaptation of AI regulations • Aware that assessing the intent behind AI design involves examining all steps of the AI life cycle, starting with the stage of conceptualisation • Assess the compliance of an AI tool with ethical regulations, as well as review AI regulations and inform adaptation
AI techniques and applications	AI foundations	• Build basic knowledge and skills on AI, particularly with respect to data and algorithms, understanding the importance of the interdisciplinary foundational knowledge required to gradually deepen understanding of data and algorithms • Connect conceptual knowledge on AI with their activities in society and daily life

	Application skills	• Construct an age-appropriate understanding of data, AI algorithms and programming, as well as acquire transferable application skills • Critically evaluate and leverage free and/or open-source AI tools, programming libraries and datasets
	Creating AI tools	• Apply knowledge and skills on data and algorithms to customise existing AI toolkits to create task-based AI tools • Integrate their human-centred mindset and ethical considerations into the assessment of existing AI resources • Develop the social and emotional skills needed to engage in creating with AI, including through adaptivity, complex communication and teamwork skills
AI system design	Problem scoping	• Understand the importance of 'AI problem scoping' as the starting point for AI innovation • Examine whether AI should be used in particular situations, from a legal, ethical and logical perspective; and to define the boundaries, goals and constraints of a problem before attempting to train an AI model to solve it • Acquire the knowledge and project-planning skills needed in order to conceptualise and construct an AI system
	Architecture design	• Cultivate basic methodological knowledge and technical skills to configure a scalable, maintainable and reusable architecture for an AI system covering layers of data, algorithms, models and application interfaces • Develop the interdisciplinary skills necessary to leverage datasets, programming tools and computational resources to construct a prototype AI system

	Iteration and feedback	• Apply their interdisciplinary knowledge and practical methods to evaluate the appropriateness and methodological robustness of an AI model and its impact on individual users, societies and the environment • Acquire age-appropriate technical skills to improve the quality of datasets, reconfigure algorithms and enhance architectures in response to results of tests and feedback • Apply a human-centred mindset and ethical principles in simulating decision-making on when an AI system should be shut down and how its negative impact can be mitigated • Cultivate their identities as co-creators within the wider AI community

Adapted from: Miao, F., & Shiohira, K. (2024). *AI competency framework for students*. United Nations Educational, Scientific and Cultural Organization. https://doi.org/10.54675/JKJB9835

Appendix C: AI CFT — Competency Aspects, Blocks, Skills and Values

Competency aspects	Competency blocks	Outcomes
Human-centred mindset	Human agency	• Have a critical understanding that AI is human-led, and that corporate and individual decisions of AI creators have a profound impact on human autonomy and rights • Aware of the importance of human agency when evaluating and using AI tools
	Human accountability	• Demonstrate a deepened understanding of human accountability and human determination in the proper deployment and use of AI • Demonstrate a critical capacity to assess AI's capabilities in facilitating human–AI decision loops
	Social responsibility	• Actively participate in and contribute to the building of inclusive AI societies guided by a critical understanding of the implications of AI for societal norms
Ethics of AI	Ethical principles	• Have a basic understanding of ethical issues surrounding AI and of the principles required for ethical human–AI interactions
	Safe and responsible use	• Internalise essential ethical rules for safe and responsible use of AI • Habitually incorporate these ethics into evaluations and utilisations of AI tools, data and AI-generated content in education
	Co-creating ethical rules	• Champion the ethics of AI through critical advocacy, leading discussions and actions that address ethical, sociocultural and

		environmental concerns in the design and use of AI
AI foundations and applications	Basic AI techniques and applications	• Acquire basic conceptual knowledge on AI (e.g., definition of AI, how AI models are trained, and knowledge about data and algorithms) to examine the appropriateness of specific AI tools for education and operate validated AI tools
	Application skills	• Proficiently operate AI tools adopted in educational settings • Deepen their knowledge of various categories of AI technologies and their practical skills concerning data and algorithms
	Creating with AI	• Customise or modify AI tools in a proficient manner • Apply enhanced conceptual knowledge and operational skills to create AI-assisted inclusive learning environments
AI pedagogy	AI-assisted teaching	• Identify and leverage the pedagogical benefits of AI tools to facilitate subject-specific lesson planning, teaching and assessment while mitigating the risks

	AI-pedagogy integration	• Adeptly integrate AI into the design and facilitation of student-centred learning practices to:
		  ○ Foster engagement
		  ○ Support differentiated learning
		  ○ Enhance teacher-student interactions

	AI-enhanced pedagogical innovation	• Critically assess AI's impact on teaching, learning and assessment • Plan and facilitate AI-immersed learning scenarios to support students' subject-specific or interdisciplinary learning, critical thinking and problem-solving

		• Leverage data and feedback to continuously explore student-centred pedagogical innovation
AI for professional development	Enabling lifelong professional learning	• Explore the use of AI tools to enhance professional development and reflective practices • Assess learning needs and personalise their learning pathways
	AI to enhance organisational learning:	• Confidently utilise AI tools for tailored participation in collaborative professional learning communities
	AI to support professional development	• Customise and modify AI tools to enhance professional development and to continuously test and validate strategies on the effective use of AI

Adapted from: Miao, F., & Cukurova, M. (2024). *AI competency framework for teachers*. United Nations Educational, Scientific and Cultural Organization. https://doi.org/10.54675/ZJTE2084

Appendix D: AI Lit Competences

Domains	Competency	Knowledge, skills, attitudes	Outcome
Engaging AI	Recognise AI's role and influence in different contexts	**Knowledge** K1.4: AI systems operate differently depending on their purpose, whether to create, predict, recommend or respond K5.1: AI plays an increasingly prevalent role in decision-making that impacts humans, from hiring practices to healthcare to criminal justice **Skills** Self and social awareness **Attitudes** Curious, responsible	Learners identify the presence of AI in everyday tools and systems and consider its purpose in various situations, such as content recommendations or adaptive learning. They reflect on how AI influences their choices, learning and perceptions.
	Evaluate whether AI outputs should be accepted, revised or rejected	**Knowledge** K4.1: AI excels at pattern recognition and automation but lacks emotions, ethical reasoning, context and originality K4.3: The capability of generative AI, particularly large language models (LLMs), to generate human-like content can make	Learners critically assess the accuracy and fairness of AI-generated content, recognising that AI can generate misinformation or biased outputs. They decide whether to trust, modify or override AI outputs by considering their potential impact on themselves and others.

		it difficult to distinguish fact from fabrication, increasing the potential to generate misinformation, deepfakes or manipulative materials **Skills** Critical thinking **Attitudes** Responsible	
	Examine how predictive AI systems provide recommendations that can inform and limit perspectives	**Knowledge** K1.1: AI systems use algorithms that combine step-by-step procedures with statistical inferences (e.g., weights and biases) to process data, detect patterns and generate probable outputs K4.3: The capability of generative AI, particularly large language models (LLMs), to generate human-like content can make it difficult to distinguish fact from fabrication, increasing the potential to generate misinformation, deepfakes or manipulative materials **Skills** Self and social awareness	Learners explore how AI uses data patterns to offer suggestions (e.g., what to watch, buy, or read) and consider how those recommendations may both support learning or decision-making and reinforce narrow viewpoints or biases.

		Attitudes Curious	
	Explain how AI could be used to amplify societal biases	**Knowledge** K2.1: Building and maintaining AI systems relies on humans to design algorithms, collect and label data, and moderate harmful content. These systems reflect human choices, assumptions and labour practices, shaped by unequal global conditions K2.5: Bias inherently exists in AI systems, which can also reflect societal biases embedded in its training data or algorithm design. Humans can perpetuate or mitigate harmful biases in AI systems during the design, development or testing process **Skills** Critical thinking, self and social awareness, problem-solving **Attitudes** Empathetic, responsible	Learners investigate how AI systems, such as facial recognition or hiring algorithms, reflect human decisions and data, and identify ways that bias in data or design can lead to unfair outcomes for different groups of people.
	Describe how AI systems consume energy and natural	**Knowledge** K4.2: AI requires vast amounts of computing power and data, which	Learners can describe how AI systems consume energy and natural resources

	resources	consumes energy, thus demanding limited natural resources and increasing carbon emissions. AI's long-term sustainability impact, both positive and negative, largely depends on how it is implemented and utilised **Skills** Self and social awareness **Attitudes** Responsible	
	Analyse how well the use of an AI system aligns with ethical principles and human values	**Knowledge** K1.4: AI systems operate differently depending on their purpose, whether to create, predict, recommend or respond K3.3: While AI can support analysis and prediction, humans must be responsible for decisions that reflect human judgment and ethical considerations K5.4: Ethical AI design encompasses fairness, transparency, explainability, accountability, respect for privacy and legal compliance **Skills**	Learners assess whether using AI in a given situation, such as surveillance cameras in public spaces or moderating online content, supports values such as fairness, transparency and privacy. They reflect on whether its use is appropriate, beneficial, or potentially harmful

		Critical thinking, self and social awareness, problem-solving **Attitudes** Responsible	
	Connect AI's social and ethical impacts to its technical capabilities and limitations	**Knowledge** K2.1: Building and maintaining AI systems relies on humans to design algorithms, collect and label data and moderate harmful content. These systems reflect human choices, assumptions and labour practices, shaped by unequal global conditions K5.2: AI systems must be understood, audited and regulated to ensure that their use leads to more benefits than harm for individuals and society **Skills** Self and social awareness, problem-solving **Attitudes** Curious, empathetic, responsible	Learners explore how AI's strengths and weaknesses affect how it is used in society. They connect the design and function of AI systems to real-world impact on people, communities and systems
Creating with AI	Use AI systems to explore new	**Knowledge** K4.1: AI excels at pattern recognition and	Learners experiment with AI to expand their thinking, generate new ideas or

	perspectives and approaches that build upon original ideas	automation but lacks emotions, ethical reasoning, context and originality **Skills** Creativity **Attitudes** Innovative, adaptable	consider alternative viewpoints. They stay accountable for the final content while letting AI support their creative process
	Visualise, prototype and combine ideas using different types of AI systems	**Knowledge** K1.4: AI systems operate differently depending on their purpose, whether to create, predict, recommend or respond **Skills** Collaboration, creativity **Attitudes** Curious, adaptable	Learners try out AI tools that operate in different formats (text, images, music, etc.) to explore and refine new ideas. They combine outputs into a meaningful product or solution.
	Collaborate with generative AI systems to elicit feedback, refine results and reflect on thought processes	**Knowledge** K2.3: AI systems gather new data from interactions with users, decisions, processes and outputs may be directly influenced by inputs in real time **Skills** Computational thinking, creativity	Learners engage in an iterative process with AI by testing prompts and refining AI-generated outputs, and then reflect on how the interaction shaped their thinking and choices

		Attitudes Innovative, Adaptable	
	Analyse how AI can safeguard or violate content authenticity and intellectual property	**Knowledge** K5.3: Generative AI and Large Language Models create content based on existing materials in training data, which includes copyright-protected work, thereby raising questions about authenticity, authorship and ownership **Skills** Self and social awareness, problem-solving **Attitudes** Empathetic, responsible	Learners explore how AI-generated content may borrow from or replicate existing work, and consider when that use is fair, original, or in need of attribution. They reflect on the ethical implications of AI-assisted creation
	Explain how AI systems perform tasks using precise language that avoids anthropomorphism	**Knowledge** K1.3: Generative AI uses probabilities to generate human-like outputs across various modalities (e.g., text, audio, visuals) but lacks authentic understanding and intent K1.4: AI systems operate differently depending on their purpose, whether to create, predict, recommend or respond	Learners describe how AI operates in realistic, accurate terms, avoiding language that suggests AI has human feelings or understanding. They understand that their language can either clarify or perpetuate misconceptions about AI.

		Skills Communication **Attitudes** Responsible	
Managing AI	Decide whether to use AI systems based on the nature of the task	**Knowledge** K4.1: AI excels at pattern recognition and automation but lacks emotions, ethical reasoning, context and originality K5.4: Ethical AI design encompasses fairness, transparency, explainability, accountability, respect for privacy and legal compliance **Skills** Problem-solving, computational thinking **Attitudes** Responsible, innovative	Learners assess whether AI is the right tool for a specific situation. They consider factors like the complexity of the task, the need for human judgment and the ethical implications.
	Decompose a problem based on the capabilities and limitations of both AI systems and humans	**Knowledge** K4.1: AI excels at pattern recognition and automation but lacks emotions, ethical reasoning, context and originality **Skills** Collaboration, computational thinking,	Learners break down a complex task and decide which parts can be handled by AI and which require human involvement. They distribute tasks based on their nature and human and AI strength.

		problem-solving **Attitudes** Innovative, adaptable	
	Direct generative AI systems by providing specific instructions, appropriate context and evaluation criteria	**Knowledge** K1.3: Generative AI uses probabilities to generate human-like outputs across various modalities (e.g., text, audio, visuals) but lacks authentic understanding and intent K2.3: AI systems gather new data from interactions with users; decisions, processes and outputs may be directly influenced by inputs in real time **Skills** Collaboration, computational thinking **Attitudes** Innovative, adaptable	Learners practice prompt engineering by giving AI clear, structured inputs to guide outputs that meet expectations and goals.
	Delegate tasks to AI systems to appropriately automate or augment human workflows	**Knowledge** K3.1: AI systems automate structured tasks, augment decision-making and transform industries, requiring humans to adapt, reskill and upskill	Learners identify opportunities to offload repetitive or structured tasks to AI, allowing people to focus on creativity, ethics or decision-making.

		Skills Collaboration, problem-solving **Attitudes** Innovative	
	Develop and communicate guidelines for using AI systems that align with human values, promote fairness and prioritise transparency	**Knowledge** K5.4: Ethical AI design encompasses fairness, transparency, explainability, accountability, respect for privacy and legal compliance **Skills** Communication, critical thinking, self and social awareness **Attitudes** Responsible, empathetic	Learners create or reinforce responsible guidelines for AI use in academic contexts. They consider existing guidelines from local, national, or international organisations, such as the European Commission or the OECD.
Designing AI	Describe how AI systems can be designed to support a solution to a community problem	**Knowledge** K2.3: AI systems gather new data from interactions with users; decisions, processes and outputs may be directly influenced by inputs in real time K3.2: AI integration requires individuals to determine which tasks are best suited for machines and which require human intervention or expertise	Learners explore how AI can solve real-world problems by identifying a community need that could be addressed with AI, considering how to design AI to contribute to a solution, and evaluating the potential benefits, risks and limitations.

		Skills Collaboration, problem-solving, self and social awareness **Attitudes** Curious, innovative, responsible	
	Compare the capabilities and limitations of AI systems that follow algorithms created by humans with those that make predictions based on data	**Knowledge** K1.2: Machines “learn” by inferring how to generate outputs such as predictions, content and recommendations that influence physical or virtual environments, in response to information from the input they receive. They do so with varying levels of autonomy and adaptiveness after deployment K1.4: AI systems operate differently depending on their purpose, whether to create, predict, recommend, or respond **Skills** Computational thinking, problem-solving **Attitudes** Curious	Learners examine the difference between systems that follow fixed rules (or manually programmed logic) and machine learning models to understand the value of machine learning and determine when each approach is most useful or appropriate.
	Collect and curate data that could be	**Knowledge** K1.2: Machines “learn” by inferring how to	Learners discover how data is labelled, selected and prepared to train an AI model.

	used to train an AI model by considering relevance, representation and potential impact	generate outputs such as predictions, content and recommendations that influence physical or virtual environments, in response to information from the input they receive; they do so with varying levels of autonomy and adaptiveness after deployment K2.2: AI is trained on vast datasets sourced from publicly available information, user-generated content, curated databases and real-world data collected through sensors, interactions and digital systems K2.4: AI systems are trained to identify patterns among data elements that humans have selected, categorised and prioritised **Skills** Computational thinking, self and social awareness **Attitudes** Innovative, responsible	They learn how data quality and representation affect the model's performance and potential effect on people.
	Evaluate AI systems using defined criteria,	**Knowledge** K1.2: Machines "learn" by inferring how to	Learners set criteria for a successful AI system, test it with various inputs, and

	expected outcomes and user feedback	generate outputs such as predictions, content and recommendations that influence physical or virtual environments, in response to information from the input they receive; they do so with varying levels of autonomy and adaptiveness after deployment K2.3: AI systems gather new data from interactions with users; decisions, processes and outputs may be directly influenced by inputs in real time **Skills** Collaboration, computational thinking **Attitudes** Innovative, adaptable	evaluate its performance to make improvements. They use an iterative process shaped by feedback from diverse users.
	Describe an AI model's purpose, intended users and its limitations	**Knowledge** K1.2: Machines "learn" by inferring how to generate outputs such as predictions, content and recommendations that influence physical or virtual environments, in response to information from the input they receive; they do so with varying levels of autonomy and adaptiveness after deployment	Learners describe the purpose of an AI model, the data used to train it, and what it can or cannot do well. They help others develop a realistic understanding of the model's capabilities and limitations.

		K2.1: Building and maintaining AI systems relies on humans to design algorithms, collect and label data, and moderate harmful content; these systems reflect human choices, assumptions and labour practices, shaped by unequal global conditions **Skills** Communication, problem-solving, self and social awareness **Attitudes** Curious, responsible	

Adapted from: Organisation for Economic Cooperation and Development. (2025). *Empowering learners for the age of AI: An AI literacy framework for primary and secondary education*. https://ailiteracyframework.org/wp-content/uploads/2025/05/AILitFramework_ReviewDraft.pdf

Appendix E: Overview of Skills and Attitudes from AI Lit Framework

Table E1: Skills from AI Lit Framework

Skills	Description
Critical thinking	Evaluate generative AI content for accuracy, fairness and bias to make informed ethical decisions
Creativity	Collaborate with AI to create and refine original ideas while considering issues of ownership, attribution and responsible use
Computational thinking	Decompose problems and provide instructions in ways that allow AI systems to effectively contribute to solutions
Self and social awareness	Recognise how AI influences personal choices, relationships and communities, and reflect on its broader societal and environmental impact
Collaboration	Work effectively with AI and humans by communicating clearly, giving feedback and navigating shared tasks
Communication	Explain how AI is used in a way that promotes transparency, avoids anthropomorphism and encourages responsible use
Problem solving	Determine when and how to use AI for a task by assessing its capabilities, risks and ethical implications

Adapted from: Organisation for Economic Cooperation and Development. (2025). *Empowering learners for the age of AI: An AI literacy framework for primary and secondary education*. https://ailiteracyframework.org/wp-content/uploads/2025/05/AILitFramework_ReviewDraft.pdf

Table E2: Attitudes from AI Lit Framework

Attitudes	Description
Responsible	Learners use AI carefully and responsibly, considering both intended and unintended effects. They strive to prevent harm and uphold everyone's right to understand and make informed decisions about AI use and its impact.
Curious	Learners seek to understand both AI's current capabilities and potential future developments, as well as its implications for their personal and professional lives. They view learning as a continuous process and engage in exploration and experimentation to generate meaningful insights.
Innovative	Learners actively seek to leverage AI to address real-world challenges and embrace emerging opportunities. They experiment with different approaches, apply creative thinking to problem-solving, and recognise AI as a tool for generating positive impact in their own lives and in the lives of others.
Adaptable	Learners demonstrate perseverance and adaptability when engaging with AI, remaining open to diverse ideas, perspectives and approaches. They recognise that effective collaboration with AI is an iterative process guided by feedback and continuous refinement.
Empathetic	Learners critically assess the impact of AI on individuals, communities and the environment. They consider both its benefits and potential risks, recognising that AI's effects may differ across various groups.

Adapted from: Organisation for Economic Cooperation and Development. (2025). *Empowering learners for the age of AI: An AI literacy framework for primary and secondary education*. https://ailiteracyframework.org/wp-content/uploads/2025/05/AILitFramework_ReviewDraft.pdf

Appendix F: EdTech Masterplan 2030 — Nine Digital Competences

Component	Digital competency	Outcomes
Find	Digital safety and security	Individuals are able to understand online behaviour and gain awareness on how to protect oneself in the online space.
	Digital information management	Individuals are able to employ effective strategies to search for information and resources, exercising discernment by evaluating the accuracy, credibility and relevance of the information, as well as distilling and synthesising essential content from the vast amount of information available online.
	Digital responsibility	Individuals demonstrate respect for oneself and others, and practise safe, responsible and ethical use when navigating the online space.
Think	Data competencies	Individuals can read, understand, interpret, manipulate, analyse and present data in meaningful ways.
	Computational thinking	Individuals can apply computational thinking in conjunction with technological tools to effectively solve problems, such as when developing and testing solutions.
Apply	Device and software Operations	Individuals possess an understanding of how devices and software function, enabling them to use these technologies effectively and productively.
	Digital knowledge currency	Individuals remain informed about technological developments and the effective use of digital resources.
Create	Coding and programming	Individuals are capable of using a range of digital methods, such as block-based programming, text-based programming, or prompt engineering, to create digital artefacts and develop, test and debug solutions.

	Digital communication, collaboration and participation	Individuals are able to leverage digital platforms and tools to effectively communicate ideas, connect with others and contribute collaboratively towards a common goal.

Adapted from: Ministry of Education. (2023, September 20). *Digital literacy and technological skills.* https://www.moe.gov.sg/education-in-sg/educational-technology-journey/edtech-masterplan/digital-literacy-and-technological-skills

Appendix G: S.U.R.E for Schools — Modules and Learning Outcomes

Education Levels	**Modules**	**Learning outcomes**
Basic level [for primary schools]	DS7 - Understanding deepfake technologies	• What are deepfakes • How are deepfakes made • What are the harmful sides of deepfakes • How to deal with deepfakes
	DW5 - Navigating generative AI	• What is generative AI • How does generative AI work • Understand that output generated by AI is not real

Intermediate level [for secondary schools]	DS7 - Understanding deepfake technologies	• Understand more about deepfake technology
		• Learn how to verify information when it comes to deepfake technologies on the internet
		  ○ Check the source
		  ○ Consider the context
		  ○ Examine the content

	DW5 - Navigating generative AI	• Learn about generative AI and what it can do
		• Understand the challenges that arise from using generative AI
		• Minimise the risks by:
		  ○ Be clear with AI prompts
		  ○ Be cognisant that AI is not a search engine
		  ○ Be careful not to share any sensitive or personal information with AI

		○ Be clever and always fact-check and verify the output against trusted sources ○ Be conscientious about giving credit where it is due
Advanced level [for pre-university and junior colleges]	DS7 - Understanding deepfake Technologies	• Understand the uses of deepfake technology • Learn about the ethical and societal implications that deepfake technologies bring
	DW5 - Navigating generative AI	• Learn about data biases and the risks that one may encounter using generative AI

Appendix H: About the Authors

CHEW Han Ei leads the Governance & Economy cluster at the Institute of Policy Studies (IPS). His work focuses on quantitative policy research, with a strong interest in online harms, digital trust and technology adoption.

He has served as Principal Investigator for multiple large-scale research grants and collaborates closely with public agencies to inform decision-making and policy development. His approach is empirically grounded and hands-on — from designing social science research projects to leading data analyses that shape real-world outcomes.

Outside of IPS, Han Ei serves on the board of SG Her Empowerment and is a pro bono Research Consultant to UNESCO. Some of his key international projects for UNESCO include “Reading in the Mobile Era: A Study of Mobile Reading in Developing Countries” and “I’d Blush If I Could: Closing Gender Divides in Digital Skills through Education”.

Han Ei earned his PhD in Media and Information Studies from Michigan State University. He also writes *The Chart Doctor Has Issues* — a Substack newsletter on data storytelling, visual best practices and the occasional chart takedown.

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Her research interests are in media regulation and digital policy, social media governance, digital literacy and policy communication. Dr Soon has written over 50 media commentaries on the impact of technology, media regulation, digital literacy and digital upskilling of citizens and workers, and public communication. She has single-authored and co-authored more than 80 research reports, journal articles, book chapters and conference papers. Her book, *Mobile Communication and Online Falsehoods: Trends, Impact and Practice*, published by Springer Nature in 2023, addresses existing gaps in research and practice in the management of online falsehoods on instant messaging platforms in Asia.

Dr Soon is currently Vice Chair of Singapore's Media Literacy Council. She is also a member of the Ministry of Culture, Community and Youth's Co-Governance Community of Practice, and serves on the National Crime Prevention Council.

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