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From Digital Literacy to AI Agency: A Culturally Responsive Framework for Orang Asli Communities in Malaysia

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ABSTRACT

The rapid expansion of artificial intelligence (AI) principally generative AI is creating a new form of digital inequality that cannot be understood through internet access or conventional digital literacy alone. For Indigenous communities, meaningful AI inclusion demands not only technical competence but also critical understanding, cultural relevance, trusted mediation, collective capability besides control over knowledge and data. This conceptual paper develops a Culturally Responsive AI Literacy and Agency Framework for Orang Asli communities in Malaysia over an integrative synthesis of literature on digital literacy, AI literacy, digital inclusion, critical digital literacy, culturally responsive education, the Capability Approach, human-centred AI, Indigenous digital inclusion and Indigenous data sovereignty. The framework comprises ten interconnected dimensions: digital foundations, AI awareness, functional AI literacy, critical AI literacy, ethical AI literacy, cultural and linguistic relevance, trust, safety and community mediation, Indigenous knowledge and data sovereignty, community support and collective capability and AI agency. Rather than treating these dimensions as a rigid linear sequence, the framework conceptualises them as mutually reinforcing capabilities shaped by social, cultural, institutional and technological conditions. The paper advances AI-literacy scholarship by shifting attention from skills to capabilities, from individual competence to collective capacity and from AI adoption to AI agency. AI agency is conceptualised as the capacity of individuals and communities to make informed, critical, culturally meaningful and autonomous decisions regarding whether, why, when and how AI should be utilized. The framework provides a foundation for future empirical validation, culturally responsive AI education, Indigenous digital policy, measurement development and human-centred AI design.

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1. Introduction

1.1 The Transition from the Digital Divide to the AI Divide

The rapid diffusion of artificial intelligence (AI) specifically generative AI is transforming how individuals access information, learn, communicate, work, obtain services and make everyday decisions. AI-enabled systems are increasingly embedded in education, employment, public administration, healthcare, communication platforms and digital services besides making the capacity to engage meaningfully with AI an emerging condition of social and economic participation [39, 64]. UNESCO's AI competency agenda similarly reflects a shift from simply accessing digital technologies towards developing the knowledge, judgement and responsibility necessary to engage with AI systems [13, 74]. Consequently, inequalities traditionally understood through the digital divide are increasingly intersecting with a new form of inequality: the AI divide.

Owning a device and having an internet connection are no longer enough for meaningful participation in the modern digital landscape. True empowerment requires a continuous, multi-layered evolution of skills [37, 67]. A person may possess a smartphone and internet access yet lack the knowledge required to recognise AI, formulate effective interactions, evaluate generated information, identify algorithmic bias, protect personal or community data or determine when AI should not be utilized. The emerging progression can therefore be conceptualised as a logical journey moving from digital access to digital literacy, advancing through AI literacy and ultimately culminating in true AI agency. While digital access enables connectivity and digital literacy supports participation in conventional digital environments, AI literacy requires users to understand, utilize, critically evaluate and ethically engage with increasingly autonomous and generative systems [33, 74, 23]. AI agency extends this progression further by emphasising people's capacity to make informed and autonomous decisions about whether, why, when and how AI should shape their lives.

1.2 Limitations of Conventional AI Literacy

Existing AI literacy frameworks have substantially advanced understanding of the competencies required for meaningful engagement with AI. Prominent approaches emphasise the ability to recognise AI, understand its functions and limitations, interact with AI systems, evaluate AI-generated outputs, and address associated ethical implications [22, 73]. More recent scholarship has expanded these concerns to include prompting, generative AI interaction, critical evaluation, and responsible utilisation. Nevertheless, AI literacy continues to be conceptualised predominantly through competency-oriented frameworks that are often situated within formal educational settings [36, 70]. Recent scholarship increasingly recognises that critical AI literacy is socioculturally situated rather than reducible to a universal set of technical competencies [6, 17].

Such assumptions become problematic when existing frameworks are applied to Orang Asli and other marginalised communities, where infrastructure, language, cultural knowledge systems, learning practices, institutional trust, and relationships with technology may differ significantly from those assumed in mainstream settings. An individualised definition of AI competence may therefore obscure the importance of collective learning, community authority, cultural meaning, and community control over knowledge. This limitation suggests the need to conceptualise AI literacy beyond individual technical competencies and to consider how AI engagement is shaped by the social, cultural, and communal contexts in which knowledge is produced, shared, and governed.

1.3 The Orang Asli Context

These concerns are particularly relevant to the Orang Asli, the Indigenous peoples of Peninsular Malaysia. Importantly, the Orang Asli should not be treated as a culturally homogeneous population, given the substantial diversity that exists across their communities [11, 38, 66, 28]. The Orang Asli comprise three major groups—Melayu Proto, Negrito, and Senoi—encompassing 18 ethnic groups with distinct linguistic, geographical, cultural, and socio-economic characteristics [20, 18, 8, 72]. These differences are reflected in variations in language, geographical location, cultural practices, livelihoods, educational experiences, and relationships with wider institutions and technologies. Such diversity makes universal assumptions about technological readiness or AI competence particularly inappropriate.

The central problem, therefore, should not be framed as a deficiency within Orang Asli communities, but rather as a potential mismatch between mainstream AI systems and literacy models and the cultural, linguistic, social, and epistemic contexts in which these technologies are encountered. A culturally responsive approach to AI literacy should consequently recognise that meaningful AI engagement may be shaped not only by individual competencies, but also by community practices, cultural knowledge, social relationships, and locally grounded ways of understanding and governing technology.

1.4 Research Gap

Three interconnected gaps consequently emerge. First, dominant AI literacy frameworks have largely been developed for mainstream educational settings and digitally connected populations, limiting their applicability to communities with distinct cultural, linguistic and technological contexts. Second, key considerations such as cultural responsiveness, Indigenous knowledge systems, linguistic diversity, community trust, collective capability and data sovereignty remain insufficiently incorporated into mainstream AI literacy conceptualisations. This limitation is particularly significant for Orang Asli communities, given growing concerns surrounding the representation of Indigenous knowledge, informed consent, data ownership and governance in AI-mediated environments. Third, there remains limited conceptual scholarship explaining how Orang Asli communities can progress beyond foundational digital capabilities towards meaningful participation, control and agency in their engagement with AI.

1.5 Purpose and Contribution

Addressing such gaps, this conceptual paper proposes a Culturally Responsive AI Literacy and Agency Framework for Orang Asli Communities. The framework makes three contributions. First, it extends AI literacy beyond functional and technical competency towards critical, ethical, cultural and community capabilities. Second, it positions Orang Asli knowledge, linguistic relevance, trust, collective capability and data sovereignty as integral rather than peripheral dimensions of AI literacy. Third, it conceptualises AI agency as the higher-order outcome of inclusive AI literacy: the capacity of individuals and communities not merely to adopt AI, but to understand, evaluate, negotiate, selectively use, reject, and ultimately exercise meaningful influence over how AI intersects with their knowledge, values, priorities and futures.

2. Conceptual Development Method

This study adopts a conceptual theory-development approach to construct a culturally responsive framework that explains the progression from digital literacy to AI agency among Orang Asli communities in Malaysia. Rather than undertaking empirical testing or claiming statistical validation of the proposed relationships, the study focuses on theoretical integration and conceptual development. A conceptual approach is particularly appropriate when existing bodies of knowledge need to be synthesised, extended or reorganised to generate new theoretical explanations and relationships [3,26]. Accordingly, this study employs theory synthesis to integrate currently fragmented strands of scholarship on AI literacy, Orang Asli digital inclusion, cultural responsiveness and agency into a coherent conceptual framework.

2.1 Conceptual Approach

The framework was developed through an integrative synthesis of interdisciplinary literature spanning digital literacy, AI literacy, digital inclusion, Orang Asli digital inclusion, culturally responsive education, critical digital literacy, human-centred AI, the Capability Approach, technology adoption and Orang Asli data sovereignty. Such integration is particularly necessary since contemporary AI literacy is increasingly understood as encompassing functional, critical, ethical and sociocultural dimensions rather than technical competence alone. Recent integrative research demonstrates considerable diversity in how AI literacy is conceptualised and highlights the importance of sociocultural perspectives alongside functional competencies. Indigenous data-governance scholarship further emphasises collective authority, self-determination and community control over the collection, ownership and utilization of Orang Asli data.

2.2 Literature Selection Logic

Literature was selected based on conceptual relevance rather than through a comprehensive systematic-review protocol. This distinction is important because the primary objective of the study is theoretical integration and framework development, rather than the exhaustive identification or quantitative synthesis of all available publications. Integrative literature approaches are particularly appropriate for combining diverse theoretical and empirical perspectives to support conceptual development and theory building [54,57]. Accordingly, priority was given to foundational theoretical scholarship, influential AI literacy frameworks, recent research on generative AI, scholarship on Orang Asli technology use and Indigenous data sovereignty, Malaysian digital-inclusion studies, and relevant institutional and policy literature. Evidence concerning Orang Asli digital inclusion was used specifically to contextualise how technological participation is shaped by local informational capabilities, community capacity, and dependence on external technological infrastructures.

2.3 Framework Construction

Framework development proceeded through three stages. Stage 1 identified conceptual limitations in conventional digital and AI literacy models specifically their emphasis on individual and technical competencies. Stage 2 extracted capabilities necessary for culturally meaningful AI participation including critical evaluation, ethical engagement, linguistic and cultural relevance, trust, collective support and knowledge sovereignty. Stage 3 organised these capabilities into progressive but interacting dimensions extending from digital foundations to AI agency. The resulting framework

therefore represents a theoretically derived set of relationships and propositions for future qualitative refinement and empirical validation rather than established causal relationships.

3. From Digital Literacy To Ai Literacy

3.1 Digital Literacy as the Foundation

Digital literacy has long served as a foundation for meaningful participation in digitally mediated societies. It extends beyond the operational ability to use digital devices to encompass the capacities to access and navigate digital environments, communicate effectively, locate and critically evaluate information, create digital content, maintain online safety, and participate responsibly in social, educational and economic activities [30,34,59]. In this regard, digital literacy remains an essential prerequisite for meaningful engagement with AI. However, the conventional assumptions underpinning digital literacy are increasingly challenged by AI-mediated environments. Traditional digital interactions generally position users as active searchers, selectors, communicators and producers of information [24,69]. AI systems fundamentally alter this relationship by increasingly generating information, recommending actions, personalising content, automating decisions and mediating knowledge production [40,71]. Consequently, users are no longer interacting solely with conventional information systems, but increasingly with probabilistic systems capable of inferring, predicting, synthesising and generating outputs on their behalf [46,73]. These developments require users to understand not only how to access and use digital technologies, but also how AI systems operate, the limitations and uncertainties of their outputs, and the ethical and social implications of AI-mediated decision-making. Conventional digital literacy, while essential, is therefore insufficient on its own to prepare individuals for meaningful engagement with AI. AI literacy should consequently be understood as an extension of, rather than a replacement for, digital literacy.

3.2 Emergence of AI Literacy

AI literacy has emerged as a multidimensional construct encompassing the knowledge, skills, attitudes and critical judgement required to engage meaningfully with AI systems. Chee et al. [13] conceptualise AI literacy as a set of competencies that enables individuals to critically evaluate AI technologies, communicate and collaborate effectively with AI, and utilise AI as a tool across diverse contexts. Similarly, Parker and Becker [42] organise AI literacy into four broad competency domains: knowing and understanding AI, using and applying AI, evaluating AI, and engaging with its ethical implications. More recent frameworks have extended these competencies in response to the rapid emergence of generative AI, emphasising the ability to interact effectively with generative systems, critically assess AI-generated outputs, identify inaccuracies and hallucinations, recognise biases and limitations, and exercise responsible judgement. Recent scholarship on AI competence similarly highlights understanding, application, evaluation, ethics and responsible use as important dimensions of meaningful engagement with AI [70]. UNESCO's AI Competency Frameworks for teachers and students [60,61] further advance a human-centred approach that integrates knowledge of AI techniques and applications with ethical responsibility, human agency and responsible participation. Collectively, these developments demonstrate that AI literacy cannot be reduced to proficiency in using generative AI tools or constructing effective prompts. Rather, it requires individuals to understand the capabilities and limitations of AI, critically evaluate the reliability and appropriateness of AI-generated outputs, and exercise informed and responsible judgement when engaging with AI systems.

3.3 Critical AI Literacy

Yet functional competence represents only one dimension of meaningful participation in AI-mediated environments. Critical AI literacy extends beyond questions of how to use AI effectively to examine how AI systems operate within broader structures of power, representation and knowledge production [17]. It requires users to critically interrogate issues such as algorithmic bias, commercial interests, platform power, data extraction, surveillance, automation, misinformation and unequal representation. Emerging scholarship on critical AI literacy consequently places greater emphasis on equity, inclusion and power, particularly in relation to whose knowledge is represented, legitimised or marginalised within AI-mediated systems [41]. This perspective is particularly important for Orang Asli and other historically marginalised communities. AI systems do not operate independently of the social and institutional contexts from which their datasets, design assumptions, linguistic resources and technological priorities emerge [9]. When particular languages, cultural perspectives or knowledge traditions are inadequately represented within these systems, AI-generated content may reproduce or reinforce existing representational inequalities [58]. Critical AI literacy therefore requires communities not only to identify inaccurate or misleading information, but also to question whose perspectives are represented, whose are absent, whose values shape technological systems, and who ultimately benefits from their development and deployment [15]. Such critical engagement transforms AI literacy from instrumental competence in using AI tools into a means of interrogating the broader social, cultural and epistemic consequences of AI.

3.4 Why Existing AI-Literacy Models Are Insufficient

Despite substantial progress, existing AI literacy models remain insufficient to explain meaningful AI participation across culturally diverse contexts. Much of the field has developed around individual learners in formal educational settings or technologically mature environments, where competence is commonly conceptualised as something that individuals acquire and demonstrate. Recent integrative scholarship indicates that AI literacy increasingly encompasses functional, critical and sociocultural dimensions, suggesting that a predominantly technical understanding of AI competence is no longer sufficient [10]. In the context of Orang Asli communities, an individualised competency model may therefore under-theorise the significance of cultural meaning, collective knowledge, community mediation, trust, Indigenous languages, cultural sovereignty, structural inequalities and power relations surrounding technology.

Meaningful AI literacy must consequently extend beyond the ability to use generative AI tools or construct effective prompts [56]. For Orang Asli communities, it should encompass the capability to understand AI, critically evaluate its outputs, safeguard culturally significant knowledge, assess whether technological applications align with community values, and make informed decisions about when AI should be used, adapted, questioned, negotiated or rejected. This leads to the central conceptual transition proposed in this paper: from AI literacy as individual competence towards AI literacy as capability and agency. The relevant question is therefore no longer simply whether individuals can use AI, but whether individuals and communities possess the knowledge, resources, critical judgement, cultural authority and decision-making capacity required to shape the conditions under which AI enters and influences their lives. AI agency thus represents a higher-order form of inclusion in which communities move beyond being competent users of AI systems to becoming informed actors capable of exercising meaningful choice, control and influence over their engagement with AI.

Table 1
Evolution from Digital Access to AI Agency

Conceptual Stage	Core Focus	Central Question	Key Capabilities	Main Limitation	Relevance to Orang Asli Context
Digital Access	Physical and infrastructural access to digital technologies	<i>Can individuals and communities connect to digital environments?</i>	Internet connectivity, device availability, affordability, basic infrastructure	Access alone does not ensure meaningful or beneficial participation	Connectivity may vary across locations and communities; access must be understood alongside affordability, infrastructure, and local conditions
Digital Literacy	Effective participation in digital environments	<i>Can individuals use digital technologies meaningfully and safely?</i>	Navigating platforms, searching for information, communicating, evaluating information, creating content, online safety	Primarily designed for conventional digital environments and may not address AI-generated content or algorithmic systems	Provides the foundational capabilities required for further engagement with AI-enabled technologies
AI Awareness	Recognition and basic understanding of AI	<i>Do individuals recognise AI and understand where and how it is being used?</i>	Identifying AI systems, understanding basic AI functions, recognising capabilities and limitations, awareness of algorithmic decision-making	Awareness does not necessarily translate into effective or critical use	Helps communities distinguish AI-generated or AI-mediated information from conventional digital content
Functional AI Literacy	Practical interaction with AI systems	<i>Can individuals use AI tools effectively for purposes they value?</i>	Generating prompts, refining queries, interacting with generative AI, applying AI to learning, communication and problem-solving	Can reduce AI literacy to technical proficiency and tool use	AI use becomes meaningful when applications correspond to local needs, language, livelihoods, education, and community priorities
Critical AI Literacy	Critical evaluation of AI systems, outputs, and underlying power structures	<i>Can individuals critically assess what AI produces and how AI systems influence them?</i>	Identifying hallucinations, bias, misinformation, stereotypes, commercial interests, surveillance, data extraction, and unequal representation	Critical competence alone may not address cultural authority or collective decision-making	Particularly important where Indigenous languages, knowledge systems, and cultural perspectives may be inadequately represented in AI datasets and outputs
Ethical and Culturally Responsive AI Literacy	Responsible and culturally meaningful	<i>Can AI be used in ways that respect community</i>	Privacy, consent, verification, ethical judgement, cultural interpretation,	Ethical frameworks may remain externally imposed if	Positions cultural relevance, Indigenous knowledge,

	engagement with AI	<i>values, rights, knowledge, and cultural contexts?</i>	linguistic relevance, knowledge protection	community values and Indigenous knowledge governance are not incorporated	community trust, and data sovereignty as central components of AI literacy
AI Capability	Genuine opportunity to convert AI-related resources and competencies into valued outcomes	<i>Are individuals and communities genuinely able to benefit from AI on terms meaningful to them?</i>	Combining digital resources, AI literacy, critical judgement, cultural relevance, social support, institutional support, and community capability	Capability may still be constrained by structural inequalities, institutional power, or technological design	Moves analysis away from perceived individual deficits toward the social, cultural, institutional, and technological conditions shaping AI participation
AI Agency	Informed autonomy, collective control, and meaningful influence over AI engagement	<i>Can individuals and communities decide whether, why, when, and how AI should be used?</i>	Using, questioning, adapting, negotiating, refusing, verifying, and governing AI; protecting Indigenous knowledge and data; influencing implementation	Requires supportive institutional, technological, cultural, and governance environments to be sustained	Represents the desired higher-order outcome in which Orang Asli communities are not merely AI users but active decision-makers capable of shaping AI engagement according to their own priorities and values

Table 1 synthesises the conceptual progression from basic technological access to AI agency, demonstrating how each successive stage expands the focus from connectivity and individual competence towards critical understanding, cultural legitimacy, collective capability and meaningful control over AI. This progression suggests that AI agency cannot be adequately explained by literacy competencies alone. A broader theoretical foundation is required to account for the conversion of technological resources into meaningful capabilities, the sociocultural conditions shaping AI engagement and the rights of Orang Asli communities to exercise control over knowledge and technology. Next section of theoretical foundations, therefore integrates the Capability Approach, critical digital literacy, culturally responsive perspectives, Orang Asli data sovereignty and human-centred AI as the theoretical foundations of the proposed framework.

4. Theoretical Foundations

The proposed Culturally Responsive AI Literacy and Agency Framework is grounded in an integrated theoretical architecture rather than a single technology-adoption model. Conventional adoption theories are valuable for explaining why individuals accept or utilize technologies, but the present framework addresses a broader question: whether individuals and communities possess the substantive opportunities, critical understanding, cultural authority and decision-making power required to engage with AI on terms they value. Five complementary perspectives are therefore integrated: the Capability Approach, critical digital literacy, culturally responsive theory, Indigenous knowledge and data sovereignty and human-centred AI. Together, they provide the conceptual progression from technological resources towards meaningful AI agency.

4.1 Capability Approach

The Capability Approach, principally associated with Amartya Sen and subsequently developed by scholars such as Martha Nussbaum [49], serves as the primary theoretical foundation of the proposed framework. Rather than evaluating wellbeing or development solely in terms of access to or possession of resources, the Capability Approach focuses on people's genuine freedoms and opportunities to achieve outcomes they have reason to value [44]. A central distinction is therefore made between resources, capabilities and functionings, or realised achievements. The possession of resources does not automatically translate into the capability to achieve valued outcomes, as this conversion is shaped by a range of personal, social, institutional, environmental and structural conditions.

Applied to AI inclusion, internet connectivity, smartphones, digital devices, AI platforms and training opportunities can be understood as technological resources [4]. Their availability alone, however, does not indicate that individuals or communities possess meaningful AI capabilities. Communities with comparable levels of technological access may have substantially different opportunities to benefit from AI because of differences in digital and AI literacy, language, infrastructure, cultural relevance, social support, institutional relationships and control over data. Applications of the Capability Approach to information and communication technologies similarly demonstrate that technological access represents only an input; meaningful outcomes depend on people's genuine ability and freedom to convert available technological resources into purposes they have reason to value [4].

The central question for inclusive AI therefore shifts from simply asking, *"Do people have access to AI?"* to asking, *"What are people genuinely able to do and become through AI?"* This shift provides the theoretical bridge from AI literacy to AI agency. From this perspective, AI literacy is valuable not merely as an end in itself, but as a capability that enables individuals and communities to pursue valued educational, cultural, economic, informational and community outcomes while retaining meaningful choice, control and agency over how AI is adopted, adapted and integrated into their lives.

4.2 Critical Digital Literacy

The Capability Approach must nevertheless be complemented by a perspective that critically examines the broader structures within which technological choices and capabilities are shaped. Critical digital literacy extends digital competence beyond operational skills by examining how digital environments are structured by power, representation, algorithms, commercial interests, misinformation, platform governance and social inequalities [7]. In AI-mediated environments, this critical perspective becomes increasingly important because users engage with systems that not only deliver information but also classify, recommend, rank, predict and increasingly generate knowledge. Critical AI literacy therefore requires the capacity to interrogate how AI-generated outputs are produced, whose knowledge and perspectives are represented or marginalised, and whose interests may be privileged within these systems [52]. Algorithmic systems may shape the visibility of information, reproduce or amplify existing biases and misinformation, and reflect inequalities embedded within datasets, technological infrastructures and digital institutions [63]. Within the proposed framework, critical digital literacy therefore provides the theoretical foundation for the Critical AI Literacy dimension. Meaningful AI participation requires individuals and communities not merely to operate AI systems effectively, but also to critically question their representations, underlying assumptions, omissions, power relations and broader social and epistemic consequences.

4.3 Culturally Responsive Perspective

A culturally responsive perspective adds another essential theoretical layer by challenging the assumption that technological competence can be defined independently of social and cultural contexts. Culturally responsive education emphasises that learning becomes more meaningful when learners' cultural knowledge, prior experiences, identities, communication practices and community contexts are recognised as legitimate resources within the learning process [1]. Gay [21] similarly emphasises the importance of incorporating learners' cultural characteristics and experiences into meaningful learning, while Ladson-Billings [31] connects culturally relevant pedagogy with the development of cultural competence and critical consciousness.

Applied to AI literacy, this perspective suggests that generic competency frameworks may be inadequate when they implicitly assume dominant languages, mainstream knowledge systems, standardised learning environments or universal definitions of effective AI use. For Orang Asli communities, meaningful AI literacy should therefore be grounded in language, lived experience, local and Indigenous knowledge, community values, identity and cultural practices. Cultural responsiveness should not be treated merely as an additional contextual variable surrounding technical competence; rather, it fundamentally shapes whether AI capabilities are meaningful, accessible, usable, trustworthy and aligned with what communities themselves have reason to value.

4.4 Indigenous Knowledge and Digital Sovereignty

The framework further incorporates Indigenous knowledge and data sovereignty to address questions that conventional literacy theories rarely capture: who owns knowledge, who controls its representation, who has the authority to consent to its use, and who benefits when knowledge is transformed into data. Indigenous data sovereignty emphasises Indigenous peoples' rights and interests in governing the collection, ownership, control, application, stewardship and reuse of data relating to their communities. The CARE Principles—Collective Benefit, Authority to Control, Responsibility and Ethics—place collective rights, community authority and self-determination at the centre of responsible Indigenous data governance [12].

Generative AI intensifies these concerns because cultural materials, languages, stories, images, ecological knowledge and other forms of Indigenous knowledge may be incorporated into data ecosystems and subsequently reproduced, transformed or disseminated at scale. Recent Indigenous AI scholarship consequently raises important concerns regarding consent, cultural appropriateness, representation, collective benefit and the application of Indigenous data-sovereignty principles to AI systems and AI-generated content [45]. In the context of Orang Asli communities, culturally responsive AI literacy must therefore include the capability to understand what knowledge may or may not be shared, who has the authority to authorise its use, how community data and knowledge should be governed, and when particular technological applications should be restricted, negotiated or refused. From this perspective, data sovereignty extends AI literacy beyond responsible use and consumption towards meaningful community authority over the representation, governance and technological use of knowledge.

4.5 Human-Centred AI

Finally, Human-Centred AI (HCAI) reinforces the principle that technological progress should enhance human capabilities, autonomy and wellbeing rather than treat increasing automation or technology adoption as ends in themselves. Shneiderman's HCAI approach [53] emphasises the

design of AI systems that combine high levels of automation with meaningful human control, with the broader aim of enhancing human performance, self-efficacy, creativity, responsibility, safety and trustworthiness. Within the proposed framework, this perspective shifts the desired outcome beyond simply increasing AI adoption or use among Orang Asli communities towards ensuring that AI strengthens individual and collective capabilities while preserving human judgement, meaningful choice, cultural integrity and community control. HCAI therefore complements the preceding theoretical perspectives by positioning human and community agency, rather than technological adoption, as the ultimate objective of AI inclusion. Collectively, the five theoretical traditions are integrated into a unified conceptual logic that explains the progression from technological access and digital literacy towards culturally responsive AI capability and, ultimately, meaningful AI agency, as illustrated in Figure 1.

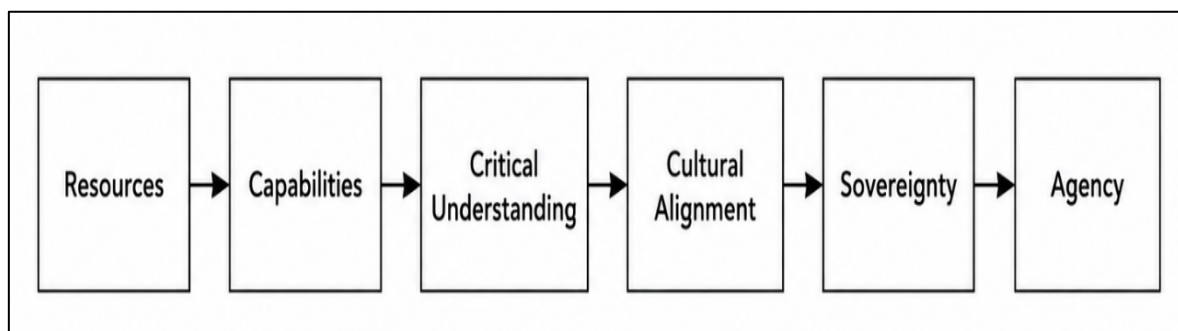


Fig. 1.Theoretical Proposition

This sequence does not imply a rigid linear process. Rather, it expresses the theoretical proposition that meaningful AI agency emerges when technological resources can be converted into genuine capabilities, exercised critically, aligned with cultural and community contexts besides supported by meaningful authority over knowledge, data and technological choices. AI inclusion is thus conceptualised not as successful technological adoption, but as the expansion of the substantive freedom of individuals and communities to determine whether, why, when and how AI should contribute to the futures they value.

5. Proposed Culturally Responsive Ai Literacy And Agency Framework

Building on the theoretical foundations established above, this paper proposes a Culturally Responsive AI Literacy and Agency Framework comprising ten interconnected dimensions: digital foundations, AI awareness, functional AI literacy, critical AI literacy, ethical AI literacy, cultural and linguistic relevance, trust and community mediation, Orang Asli knowledge and data sovereignty, community support and collective capability and AI agency. Although the dimensions suggest a developmental movement from foundational access towards higher-order agency, the framework should not be interpreted as a rigid linear sequence. Individuals and communities may develop different capabilities simultaneously, while cultural relevance, trust, community support and sovereignty operate across multiple stages of AI engagement. The framework therefore conceptualises AI literacy as an ecosystem of capabilities rather than a checklist of individual technical competencies. Table 2 consolidates the ten dimensions of the proposed framework by defining their conceptual scope, core capabilities, relevance to Orang Asli communities and respective roles in the progression towards culturally meaningful AI agency.

Table 2

10 Dimensions of the Proposed Culturally Responsive AI Literacy and Agency Framework

Dimension	Conceptual Definition	Core Capabilities / Components	Relevance to Orang Asli Communities	Role within the Framework
Digital Foundations	The basic technological resources and digital competencies required to participate meaningfully in AI-enabled environments.	Connectivity; device access; digital navigation; information searching; account management; cybersecurity awareness; digital communication.	Recognises that AI participation depends partly on infrastructural and digital conditions that may differ across communities and geographical settings.	Provides the foundational resources necessary for subsequent AI-literacy development while recognising that access alone is insufficient.
AI Awareness	The ability to recognise AI systems, understand their basic functions, and distinguish AI-mediated processes from conventional digital technologies.	Recognising AI applications; understanding generative AI; awareness of algorithmic decision-making; identifying benefits, limitations, and risks.	Enables community members to recognise when information, recommendations, or services are AI-generated or AI-mediated rather than treating them as inherently authoritative.	Establishes foundational understanding necessary for informed interaction with AI.
Functional AI Literacy	The practical capacity to interact with AI systems effectively for purposes considered useful and meaningful.	Asking questions; prompt construction and refinement; generating ideas or text; translation assistance; information retrieval; educational support; task automation.	Connects AI use with locally meaningful purposes, including education, communication, livelihoods, information access and community activities.	Converts AI awareness into practical capability and purposeful use.
Critical AI Literacy	The ability to critically examine AI outputs, underlying assumptions, limitations and wider structures of power and representation.	Detecting hallucinations; verifying information; recognising bias, stereotyping, misinformation, unreliable sources and inappropriate recommendations; questioning algorithms and platform interests.	Particularly important where Orang Asli languages, knowledge systems and cultural perspectives may be underrepresented or inaccurately represented in AI systems.	Enables users to move from passive acceptance towards critical evaluation and informed judgement.
Ethical AI Literacy	The capacity to understand and make responsible judgements about the ethical consequences of AI development and use.	Privacy; consent; copyright; data protection; academic integrity; responsible sharing; misinformation; harmful content; accountability.	Helps communities evaluate whether AI practices protect individuals and communities from privacy, informational, cultural and social harms.	Introduces normative judgement into AI engagement and distributes ethical responsibility across users, institutions and technology providers.
Cultural and Linguistic Relevance	The extent to which AI literacy and AI-enabled practices recognise and align with community language, cultural values, knowledge systems and lived realities.	Indigenous-language accessibility; culturally appropriate learning; oral traditions; local knowledge; cultural practices; ecological knowledge; community priorities.	Prevents AI literacy from being imposed through dominant-language or culturally universal assumptions and supports locally meaningful forms of engagement.	Functions as a cross-cutting condition shaping whether AI capabilities are meaningful, legitimate and usable.

Trust, Safety and Community Mediation	The relational and institutional conditions through which individuals assess the credibility, safety and appropriateness of AI technologies.	Technological trust; informational trust; institutional trust; interpersonal trust; risk awareness; trusted intermediaries; community mediation.	Community leaders, teachers, family members, NGOs, and local facilitators may play important roles in interpreting, validating and mediating AI use.	Supports calibrated trust, enabling exploration of beneficial AI while maintaining appropriate scepticism and safeguards.
Indigenous Knowledge and Data Sovereignty	The capacity of communities to exercise meaningful authority over the collection, sharing, representation, reuse and governance of culturally significant knowledge and data.	Knowledge ownership; community consent; data governance; cultural knowledge protection; control over sharing; benefit determination; responsible reuse.	Addresses risks that cultural knowledge, narratives, languages, images or ecological knowledge may be extracted, decontextualised, misrepresented or reused without appropriate community authority.	Extends AI literacy from individual data protection towards collective cultural rights and sovereignty.
Community Support and Collective Capability	The shared capability of communities to develop, distribute, and sustain AI-related knowledge and decision-making through social and institutional networks.	Peer learning; intergenerational learning; community digital facilitators; teacher support; NGO assistance; institutional support; locally led AI education.	Recognises that capabilities may be distributed across community members rather than residing equally within every individual.	Shifts the unit of analysis from the digitally competent individual to the AI-capable community.
AI Agency	The capability of individuals and communities to make informed, critical, culturally meaningful, and autonomous decisions about whether, why, when and how AI should be used.	Using, adapting, questioning, verifying, negotiating, restricting, or rejecting AI; protecting knowledge; influencing AI implementation and governance.	Positions Orang Asli communities as active decision-makers rather than passive recipients or users of technological systems.	Represents the framework's higher-order outcome, reflecting meaningful control over AI engagement rather than adoption alone.

Note: The ten dimensions are conceptually interconnected rather than strictly sequential. Digital foundations, AI awareness and functional literacy provide important enabling capabilities, while critical and ethical literacy deepen informed engagement. Cultural and linguistic relevance, trust and community mediation, Orang Asli knowledge and data sovereignty besides collective capability operate as cross-cutting conditions that influence multiple stages of AI participation. AI agency represents the higher-order outcome of these interacting capabilities and conditions.

5.1 Digital Foundations

Digital foundations represent the enabling resources and foundational capabilities required for meaningful participation in AI-mediated environments. These foundations include reliable connectivity, access to appropriate digital devices, basic digital navigation, information searching, account management, cybersecurity awareness and fundamental digital communication skills [19,71,75]. Without these foundations, opportunities to access and engage with AI-enabled systems remain constrained, regardless of the availability of AI applications.

The framework, however, deliberately distinguishes technological access from meaningful capability. Connectivity, digital devices and AI applications constitute enabling resources, but their availability does not automatically translate into meaningful AI participation. Consistent with the Capability Approach outlined in Section 4, resources acquire developmental significance only when individuals and communities possess genuine opportunities to convert them into outcomes they

have reason to value. Digital foundations are therefore necessary but insufficient conditions for AI inclusion. Accordingly, the framework rejects the assumption that closing infrastructural and access gaps alone constitutes meaningful AI inclusion; rather, such resources provide the foundation upon which higher-order AI capabilities and agency can be developed.

5.2 AI Awareness

The second dimension, AI Awareness, concerns the ability to recognise what AI is, where and how it operates, and how it differs from conventional digital technologies. It encompasses a foundational understanding of generative AI, recommendation systems, automated decision-making, and the potential benefits, risks and limitations associated with AI applications [22,55,74]. UNESCO's AI Competency Frameworks for teachers and students [60,61] similarly emphasise human-centred understanding, knowledge of AI techniques and applications, ethical considerations and responsible engagement, rather than the mere ability to use AI tools.

AI Awareness is particularly important because AI increasingly operates in ways that may not be immediately visible to users, including through search engines, social media platforms, public services, educational technologies and recommendation systems. Meaningful participation therefore requires individuals and communities to recognise when information, recommendations or decisions may be mediated or generated by AI. Awareness consequently establishes an important epistemic foundation for subsequent AI capabilities: AI-generated outputs should be understood as constructed and probabilistic outputs that require critical evaluation and human judgement, rather than being accepted as inherently accurate or authoritative knowledge.

5.3 Functional AI Literacy

Functional AI literacy concerns the practical capability to interact effectively and purposefully with AI systems. Long and Magerko [33] conceptualise AI literacy as encompassing competencies that enable individuals to critically evaluate AI, communicate and collaborate effectively with AI systems, and use AI as a tool. Similarly, Parker and Becker [42] organise AI literacy around understanding AI, using and applying AI, evaluating AI, creating with AI, and engaging with its ethical implications. Within the proposed framework, functional competencies include formulating appropriate questions, constructing and refining prompts, generating and revising text or ideas, obtaining translation assistance, retrieving information, supporting learning, and applying AI to relevant everyday tasks.

Functional AI literacy, however, should not be reduced to proficiency in prompting techniques or the mechanical use of AI tools. Its significance depends on whether AI can support purposes that individuals and communities themselves consider meaningful and valuable. AI literacy initiatives should therefore be connected to community-relevant activities rather than abstract demonstrations of technological capability. A farmer, student, community facilitator, parent, entrepreneur or cultural knowledge holder may require substantially different forms of AI interaction. Meaningfulness and relevance, rather than technological sophistication alone, therefore become the defining criteria of functional AI capability.

5.4 Critical AI Literacy

The fourth dimension moves from operating AI to critically questioning AI. Critical AI literacy encompasses the ability to recognise hallucinations, factual inaccuracies, bias, stereotypes,

misinformation, inappropriate recommendations, weak evidence and unreliable sources [5,76]. Users must recognise that fluent, coherent or confident language generated by AI does not necessarily indicate factual accuracy or reliability. More importantly, critical AI literacy extends beyond verifying individual outputs to interrogating how algorithms, datasets, platform interests, representation and unequal power relations shape what AI systems make visible, invisible or authoritative [48,68].

This capability is particularly significant for Orang Asli communities because AI systems may reproduce broader knowledge hierarchies and representational inequalities when Indigenous perspectives are inadequately represented, incorrectly contextualised or excluded from underlying datasets and knowledge systems. Critical AI literacy therefore equips users not merely to identify inaccurate outputs, but also to interrogate the conditions under which AI-generated information acquires legitimacy and authority. It consequently enables individuals and communities to question whose knowledge is represented, whose perspectives are marginalised, and how existing social and epistemic inequalities may be reproduced through AI-mediated systems.

5.5 Ethical AI Literacy

Ethical AI literacy concerns the capacity to exercise responsible and informed judgement regarding the consequences of AI use. It encompasses issues such as privacy, informed consent, copyright and attribution, misinformation, academic integrity, responsible sharing, harmful content and personal-data protection. Existing human-centred approaches to AI ethics identify ethical responsibility as a core component of meaningful AI engagement [74], while contemporary competency frameworks increasingly position responsible and human-centred participation as integral to AI capability.

The proposed framework extends this dimension beyond individual behaviour and responsibility. Ethical AI literacy should not imply that users alone bear responsibility for preventing or mitigating AI-related harms. Technology developers, governments, educational institutions, platform providers and organisations deploying AI also bear responsibilities for transparency, privacy, accessibility, representation and appropriate safeguards. Ethical AI literacy therefore encompasses both responsible personal engagement with AI and an understanding of the responsibilities and accountability of institutions that design, deploy and exercise power through AI systems.

5.6 Cultural and Linguistic Relevance

Cultural and linguistic relevance constitutes one of the principal extensions of the proposed framework beyond conventional AI literacy models. AI literacy cannot be assumed to be culturally neutral because meaningful engagement with technology is mediated by language, ways of knowing, lived experiences, identity, values, oral traditions, cultural practices, ecological knowledge and community priorities [16,65]. AI systems developed predominantly from dominant-language and mainstream digital datasets may inadequately represent Orang Asli languages, knowledge systems and epistemologies, or may interpret culturally specific concepts through inappropriate external categories.

For Orang Asli communities, culturally responsive AI literacy must therefore extend beyond the translation of generic AI training materials into local languages. It requires consideration of whether the examples, applications, languages, pedagogical approaches and definitions of beneficial AI use reflect community contexts, priorities and ways of knowing. This perspective reverses a common assumption underlying technology-inclusion initiatives: communities should not be expected to

adapt entirely to AI systems. Rather, AI education and, where possible, AI systems themselves should also be adapted to the cultural, linguistic and social contexts of the communities they are intended to serve.

5.7 Trust, Safety and Community Mediation

The seventh dimension recognises that engagement with AI occurs within broader relationships of trust, safety and social mediation. Trust should not be conceptualised as a single attitude towards technology. Instead, the framework distinguishes among technological trust in system reliability, informational trust in AI-generated outputs, institutional trust in organisations introducing or governing AI, and interpersonal trust in individuals who mediate technological engagement [29,35,50]. Community leaders, family members, teachers, NGOs, local facilitators and other trusted intermediaries may play important roles in helping individuals interpret unfamiliar AI systems, verify information, assess risks and determine whether particular applications are appropriate within specific community contexts.

Trust, however, should not imply unquestioning acceptance of AI systems or their outputs. Meaningful AI engagement requires calibrated trust: sufficient confidence to explore potentially beneficial technologies while maintaining sufficient critical awareness to question, verify or reject unreliable or inappropriate systems [25,32]. This dimension therefore moves AI literacy beyond the assumption of an isolated individual user and recognises that AI participation may be socially mediated, collectively interpreted and negotiated through trusted relationships.

5.8 Indigenous Knowledge and Data Sovereignty

Indigenous knowledge and data sovereignty constitute another central contribution of the proposed framework. Conventional AI literacy models commonly emphasise the protection of personal information but devote comparatively less attention to collective rights over culturally significant knowledge and data [10,43,62]. Indigenous data sovereignty instead foregrounds Indigenous peoples' authority and rights to govern data concerning their communities, knowledge systems, cultures, lands and futures. The CARE Principles operationalise these concerns through Collective Benefit, Authority to Control, Responsibility and Ethics, thereby placing collective rights and self-determination at the centre of responsible Indigenous data governance [12,27].

Generative AI makes this capability increasingly important because information entered into, collected by or reproduced through AI systems may extend beyond conventional forms of personal data. Orang Asli knowledge, narratives, language materials, cultural images, ecological knowledge and other forms of community information may carry collective cultural significance and therefore cannot always be treated as data belonging solely to the individual who provides them. AI literacy should consequently include the capability to ask: What knowledge should be shared? With whom? Through which systems? Under what conditions? Who has the authority to make such decisions? And for whose benefit?

From this perspective, choosing not to provide culturally sensitive knowledge to an AI platform may itself constitute a sophisticated expression of AI literacy and agency rather than technological resistance. Indigenous data sovereignty therefore expands AI literacy beyond individual privacy towards collective authority, cultural protection and meaningful community control over how knowledge is represented, accessed and used within AI-mediated environments.

5.9 Community Support and Collective Capability

The framework further challenges the assumption that AI literacy resides exclusively within individuals. The dimension of community support and collective capability recognises that technological capabilities may be distributed across social networks and community relationships. Peer learning, community digital facilitators, intergenerational knowledge exchange, teachers, NGOs, local institutions and locally led AI education initiatives may collectively expand what communities are genuinely able to achieve through technology [47,77].

This perspective shifts the relevant unit of analysis from the digitally competent individual towards the AI-capable community. Not every community member needs to possess identical levels or forms of expertise. One individual may possess technical knowledge, another linguistic expertise, another cultural authority, and another experience in evaluating digital information. Through trusted relationships and collaborative practices, these distributed capabilities can collectively support informed and culturally appropriate decision-making.

This collective perspective is particularly compatible with Indigenous data-governance principles that emphasise community authority, collective benefit and shared responsibility rather than treating technological and data-related decisions as exclusively individual matters. AI capability can therefore be understood not only as an individual attribute, but also as a collective resource generated and exercised through community relationships, knowledge and institutions.

5.10 AI Agency

The framework culminates in AI agency, defined here as the capability of individuals and communities to make informed, critical, culturally meaningful and autonomous decisions regarding whether, why, when and how AI should be used. AI agency encompasses the capacity to use and adapt AI practices, critically question AI-generated outputs, verify information, negotiate conditions of use, refuse inappropriate applications, protect community knowledge, and participate meaningfully in decisions concerning how AI systems are introduced, deployed or governed [14,51].

This conceptualisation distinguishes the proposed framework from conventional technology-adoption models. Whereas AI adoption primarily asks whether individuals or communities use AI, AI agency asks whether they possess meaningful choice, control and influence over the conditions of that use. Adoption therefore does not necessarily indicate agency. A community may adopt AI extensively while exercising limited control over how its data, knowledge or cultural representations are used. Conversely, a community that makes an informed decision not to adopt a particular AI application because it threatens cultural knowledge, privacy, community values or collective priorities may demonstrate a high level of AI agency.

AI agency therefore represents more than technological participation. It reflects the capability to make informed choices about AI, negotiate the terms of engagement, protect individual and collective interests, and influence how AI is integrated into community life. Within the proposed framework, the progression from digital foundations through AI awareness, functional, critical, ethical and culturally responsive AI literacy ultimately seeks to enable this higher-order capability: individuals and communities becoming not merely users of AI, but informed actors with meaningful authority over whether and how AI enters their lives.

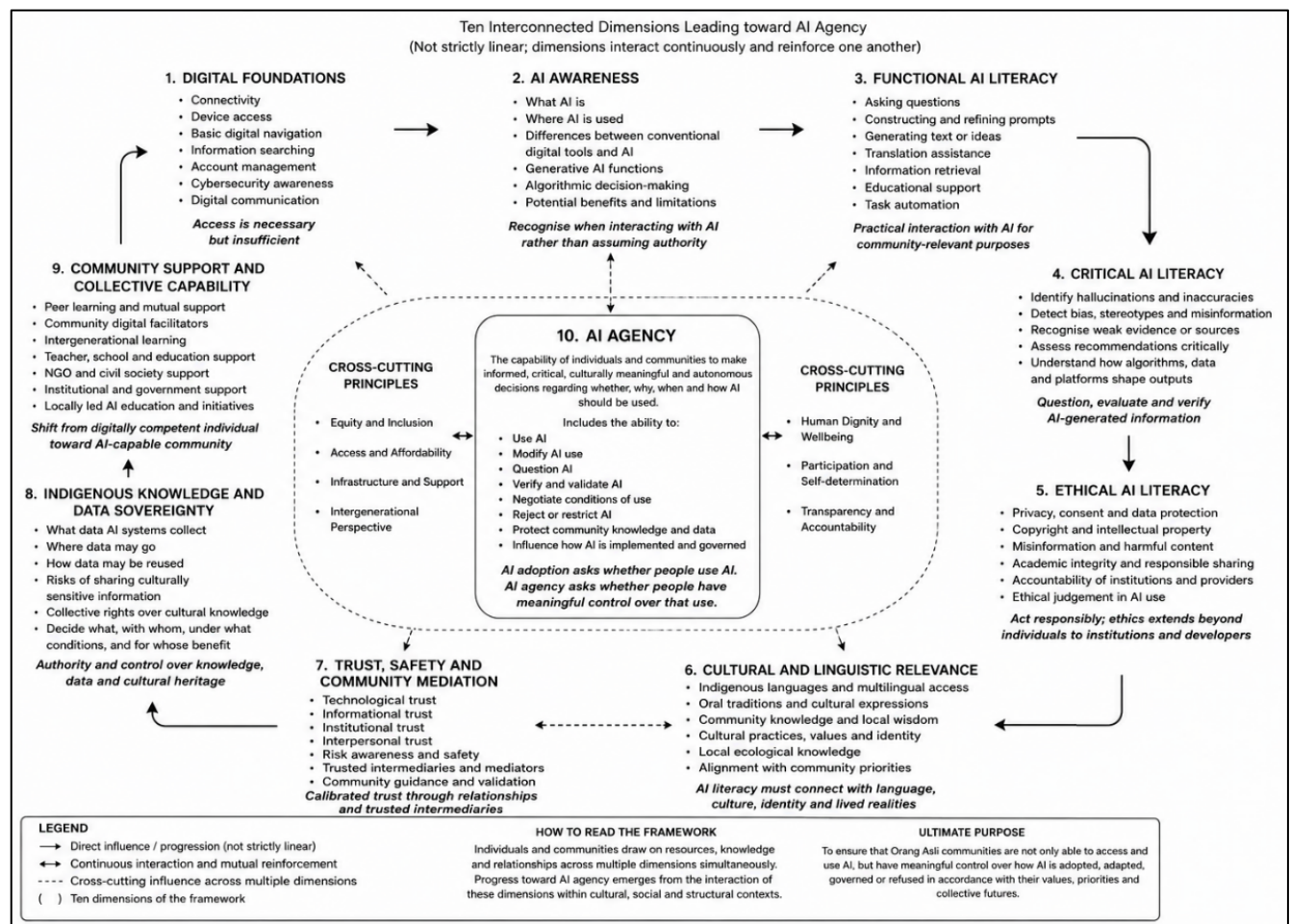


Fig. 2. Culturally Responsive AI Literacy and Agency Framework for Orang Asli Communities

Emerging scholarship on Indigenous engagement with AI and broader critical AI governance increasingly emphasises the importance of community leadership, culturally grounded technological development, and the legitimacy of communities in determining the terms under which AI is introduced and used. Accordingly, AI agency is not produced by any single competency. Rather, it emerges through the interaction of enabling resources, practical capabilities, critical judgement, ethical understanding, cultural and linguistic alignment, trusted social relationships, collective capability, and sovereignty over knowledge and data [2,17].

The proposed framework therefore reframes inclusive AI literacy as a progression from having access to and being able to operate AI towards possessing the capability, choice and authority to shape one's relationship with AI. For Orang Asli communities, meaningful AI inclusion should ultimately be assessed not by the frequency or extent of AI use, but by the degree to which communities are able to engage with, benefit from, critically evaluate, contest, adapt, govern or refuse AI in accordance with their own values, knowledge systems and collective priorities. As illustrated in Figure 2, AI agency therefore represents the culminating outcome of the framework, where meaningful inclusion is defined by informed choice and community authority rather than technological adoption alone.

6. Conceptual Relationships And Propositions

The proposed framework conceptualises the movement from digital literacy to AI agency as an interconnected capability-development process rather than a deterministic linear pathway. The

propositions below articulate theoretically derived relationships among the ten dimensions and are intended for future empirical examination. They should therefore be interpreted as conceptual claims rather than statistically established causal relationships. This approach is consistent with the Capability Approach which distinguishes possession of resources from the genuine freedom to convert those resources into valued opportunities and outcomes. Digital foundations provide the enabling conditions through which individuals might encounter and develop familiarity with AI technologies. Access to connectivity and devices however becomes meaningful only when combined with the competencies required to recognise and interact with AI systems based on proposition as follows as illustrated in Figure 3.

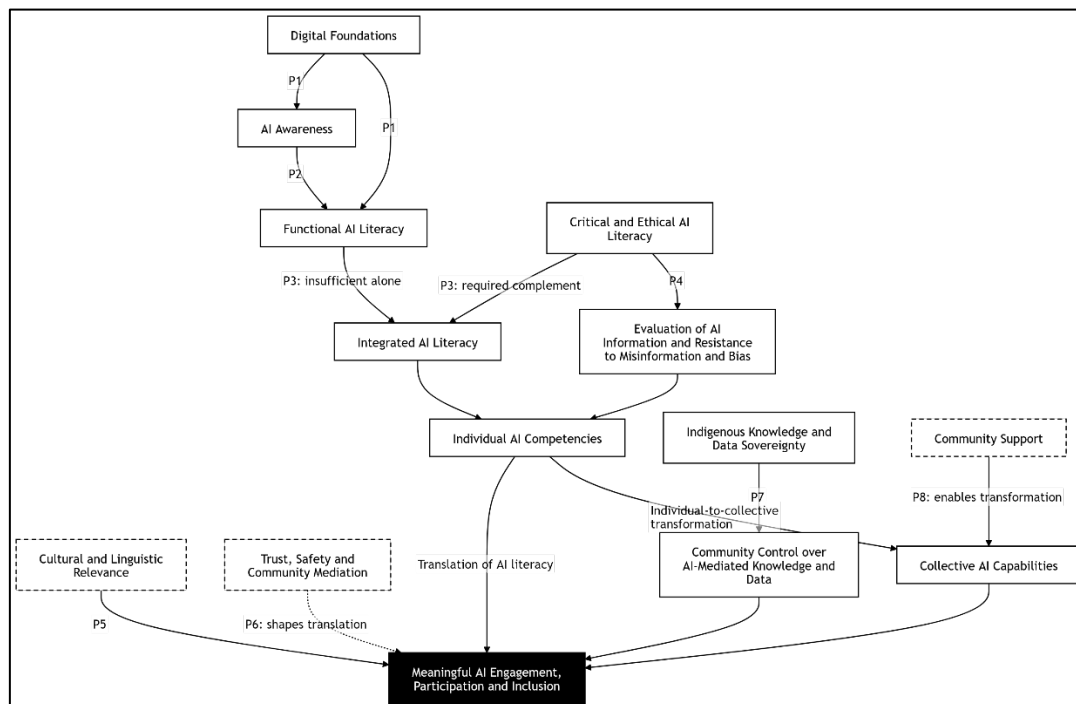


Fig. 3. Conceptual Propositions

- a. Proposition 1 (P1): Strong digital foundations facilitate the development of AI awareness and functional AI literacy.
- b. Proposition 2 (P2): AI awareness strengthens individuals' capacity to develop functional AI literacy. Functional proficiency, however, does not itself constitute meaningful AI inclusion.
- c. Proposition 3 (P3): Functional AI literacy alone is insufficient for meaningful AI inclusion unless accompanied by critical and ethical AI literacy.
- d. Proposition 4 (P4): Critical AI literacy enhances individuals' capacity to evaluate AI-generated information and resist algorithmic misinformation and bias.
- e. Proposition 5 (P5): Cultural and linguistic relevance strengthens meaningful engagement with AI technologies.
- f. Proposition 6 (P6): Trust, safety and community mediation influence the translation of AI literacy into meaningful AI participation.
- g. Proposition 7 (P7): Indigenous knowledge and data sovereignty strengthen community control over AI-mediated knowledge and data practices.
- h. Proposition 8 (P8): Community support transforms individual AI competencies into collective AI capabilities.

In this context, awareness subsequently enables users to distinguish AI-mediated processes from conventional technologies and better understand AI's functions, limitations and applications. Established AI-literacy frameworks similarly position understanding AI and interacting effectively with AI among foundational competencies. Contemporary AI competency approaches increasingly incorporate critical evaluation, ethical judgement and human-centred engagement alongside practical utilization. For culturally diverse communities, meaningful AI engagement further depends on whether technologies and literacy practices align with language, knowledge systems, lived realities and community priorities. Since technology engagement is socially situated, trusted intermediaries and perceptions of technological, informational, interpersonal and institutional safety might shape whether competencies become sustained participation. Orang Asli data-governance principles further establish that meaningful participation must incorporate collective benefit, authority to control, responsibility and ethics, thereby extending literacy beyond individual privacy towards community authority over knowledge and data. As a result, Table 3 summarises the ten conceptual propositions and demonstrates how the proposed relationships collectively shift the understanding of AI inclusion from technological access and individual competency towards culturally grounded capability, collective control and AI agency.

Table 3
Conceptual Propositions

Proposition	Conceptual Relationship	Theoretical Rationale	Expected Contribution to AI Agency
P1	Digital Foundations → AI Awareness and Functional AI Literacy	Connectivity, device access, digital navigation, information-searching skills, and basic cybersecurity provide the enabling resources required to encounter and interact with AI systems. From a Capability Approach perspective, these resources create opportunities for capability development but do not guarantee meaningful participation by themselves.	Establishes the foundational conditions from which more advanced AI capabilities can develop.
P2	AI Awareness → Functional AI Literacy	Understanding what AI is, where it operates, and what it can and cannot do helps individuals interact with AI systems more purposefully and appropriately. Awareness enables users to distinguish AI-mediated processes from conventional digital technologies.	Supports informed and purposeful AI use rather than unreflective interaction with AI tools.
P3	Functional AI Literacy + Critical AI Literacy + Ethical AI Literacy → Meaningful AI Inclusion	Technical ability to use AI does not ensure informed or responsible participation. Meaningful inclusion requires the capacity to evaluate outputs, recognise risks and limitations, and make ethically responsible decisions regarding AI use.	Moves AI participation beyond technical proficiency towards responsible, reflective, and informed engagement.
P4	Critical AI Literacy → Evaluation and Resistance to AI-Related Harm	Critical digital-literacy perspectives emphasise power, representation, algorithmic bias, misinformation, platform interests, and unequal visibility. Users therefore require the ability to interrogate AI-generated outputs rather than accepting them as authoritative.	Strengthens users' capacity to detect hallucinations, misinformation, stereotypes, bias, and inappropriate recommendations and to make independent judgements.
P5	Cultural and Linguistic Relevance → Meaningful AI Engagement	Culturally responsive perspectives suggest that learning and technology become more meaningful when connected to language, identity, lived experience, cultural practices,	Enables AI engagement to reflect Orang Asli languages, knowledge systems, cultural priorities, and lived realities,

		and community knowledge. AI competence cannot therefore be assumed to be culturally neutral.	strengthening the legitimacy and usefulness of AI.
P6	Trust, Safety and Community Mediation → Translation of AI Literacy into Participation	AI use is socially situated. Technological, informational, institutional, and interpersonal trust, together with trusted intermediaries, can influence whether individuals feel able to explore, evaluate, and sustain AI engagement.	Creates conditions for calibrated trust, where communities can benefit from AI without abandoning critical judgement or safety considerations.
P7	Indigenous Knowledge and Data Sovereignty → Community Control over AI-Mediated Knowledge and Data	Indigenous data-sovereignty perspectives foreground collective authority, consent, responsibility, and control over culturally significant knowledge and data. AI systems introduce additional risks of extraction, reuse, misrepresentation, and decontextualization.	Expands AI agency beyond individual privacy by enabling communities to determine what knowledge may be shared, reused, protected, restricted, or withheld.
P8	Community Support → Collective AI Capability	Capability development may be distributed across families, peers, teachers, community leaders, NGOs, institutions, and local facilitators rather than residing equally within every individual. Social and intergenerational learning can transform individual competencies into shared community resources.	Shifts the unit of analysis from the AI-literate individual towards the AI-capable community, strengthening collective decision-making and resilience.
P9	Functional + Critical + Ethical + Cultural + Sovereignty-Related Capabilities → AI Agency	AI agency is conceptualised as an emergent outcome arising from the interaction of multiple capabilities rather than from any single technical skill. The Capability Approach further suggests that meaningful freedom depends on the ability to convert resources and competencies into valued choices and actions.	Enables individuals and communities to use, evaluate, negotiate, adapt, restrict, govern, or reject AI according to their values, priorities, and circumstances.
P10	AI Agency > Access or Adoption as an Indicator of Indigenous AI Inclusion	Access measures technological availability and adoption measures use, but neither demonstrates whether individuals or communities possess meaningful choice, critical understanding, cultural authority, or control over technological engagement.	Repositions successful AI inclusion around meaningful control, self-determination, and substantive freedom, rather than simply increasing AI uptake.

Note: The propositions are theoretically derived and do not represent empirically established causal relationships. They are intended to guide subsequent qualitative exploration, measurement development, and quantitative validation of the proposed Culturally Responsive AI Literacy and Agency Framework.

Taken together, these propositions demonstrate that AI agency cannot be reduced to technological utilization or competence. Rather, it emerges from the interaction of technical capabilities, critical judgement, ethical responsibility, cultural relevance, trusted social relationships, collective capability and sovereignty over knowledge and data.

7. Discussion And Implications

The proposed Culturally Responsive AI Literacy and Agency Framework extends current AI-literacy scholarship by repositioning AI inclusion as a question of capability, cultural legitimacy, collective participation and meaningful control rather than merely access to or competence in utilizing AI tools. This reconceptualisation is particularly significant for Orang Asli contexts wherever technological participation intersects with language, identity, community authority, knowledge governance and structural conditions.

7.1 Theoretical Implications

The framework advances existing scholarship in four principal ways. First, it shifts AI literacy from a predominantly skills-based model towards a capability-based model. Conventional competency frameworks appropriately emphasise understanding AI, applying AI tools, evaluating outputs and ethical engagement. UNESCO's AI Competency Framework, for example, combines a human-centred mindset, AI ethics, AI techniques and applications besides AI system design. The proposed framework extends this orientation by asking whether individuals and communities possess the substantive freedom to convert these competencies into outcomes they themselves value. Literacy is therefore conceptualised not simply as possession of skills but as the capability to exercise those skills under meaningful social, cultural and technological conditions.

Second, the framework changes the desired endpoint from utilization of AI into AI agency. Successful inclusion should not be measured solely through frequency of utilization, adoption intention or access to generative AI. Individuals may utilize AI extensively while possessing partial understanding of its limitations or control over how their data, knowledge and choices are mediated. Agency instead foregrounds the ability to utilize, question, negotiate, adapt, restrict or reject AI.

Third, the framework challenges the individualistic orientation of several literacy models by introducing collective and community capability. AI knowledge may be distributed among family members, educators, community facilitators, leaders, NGOs and other trusted actors. The relevant unit of analysis can therefore move from the "AI-literate individual" towards the AI-capable community.

Fourth, Orang Asli knowledge, cultural and linguistic relevance and data sovereignty are positioned as central components of meaningful AI literacy rather than supplementary considerations. The CARE Principles for Orang Asli Data Governance emphasise Collective Benefit, Authority to Control, Responsibility and Ethics, foregrounding self-determination and collective rights in data governance. This becomes increasingly consequential where AI systems might incorporate, transform, reproduce or circulate Orang Asli knowledge beyond its original cultural context. UNESCO has similarly highlighted the importance of indigenous participation, data sovereignty, cultural rights and protection against inappropriate uses of Orang Asli knowledge in AI development.

The resulting conceptual progression can be expressed through four increasingly demanding questions:

- a. Digital Divide: *Who has access?*
- b. Digital Literacy: *Who can utilize digital technologies?*
- c. AI Literacy: *Who understands and can critically engage with AI?*
- d. AI Agency: *Who can meaningfully decide how AI should shape their lives and communities?*

This progression represents the framework's central theoretical shift from technological inclusion to meaningful technological self-determination.

7.2 Educational Implications

The framework implies that AI-literacy initiatives for Orang Asli communities should begin with community-defined needs rather than technology-defined competencies. Programmes should use culturally meaningful examples, recognise linguistic diversity, incorporate experiential and locally relevant learning and involve trusted community facilitators. AI education should also move beyond

teaching prompting techniques. Participants need opportunities to verify outputs, identify hallucinations and bias, understand privacy and data rights besides critically discuss situations in which utilization of AI may be inappropriate.

This approach aligns with human-centred AI competency development, which emphasises judgement, ethics, responsibility and human agency rather than technical proficiency alone. AI literacy education should consequently enable communities not only to become better AI users but also to become more discerning decision-makers regarding AI.

7.3 Policy Implications

At policy level, inclusive AI strategies should move beyond infrastructure provision, device distribution and generic digital-skills programmes. These interventions remain necessary but they cannot alone establish meaningful AI inclusion. Policy should also support culturally adapted AI education, Orang Asli-language resources, community-based facilitators, responsible-AI safeguards, sustained community consultation and mechanisms for Orang Asli data governance.

Importantly, community participation should occur during the formulation of AI initiatives rather than after technologies have already been designed or deployed. UNESCO's work on Indigenous peoples and AI similarly emphasises participatory inclusion and warns that exclusion from AI governance might reproduce existing discriminatory structures. Policy should therefore recognise Orang Asli communities not merely as beneficiaries of digital inclusion programmes but as participants in determining the terms of AI inclusion.

7.4 Design Implications

The framework also places responsibility on AI developers and platform providers. Inclusive design requires attention to Indigenous-language representation, cultural bias, inappropriate or stereotypical outputs, low-bandwidth accessibility, explainability, privacy, consent and community-centred co-design. UNESCO's ethics framework places diversity, inclusion, equality and avoidance of discriminatory bias at the centre of responsible AI governance.

Developers should therefore ask not merely whether an AI system is technically accessible, but whether its knowledge representations, interaction mechanisms, and data practices are culturally appropriate and accountable. Community consultation and co-design are particularly important where AI systems interact with culturally significant knowledge.

Ultimately, inclusive AI literacy and inclusive AI design are mutually dependent. Communities cannot exercise meaningful AI agency when technologies remain linguistically inaccessible, culturally misaligned, opaque or extractive. Equally, technically inclusive systems cannot produce equitable outcomes where users lack the capabilities to evaluate, negotiate and govern their engagement with them. Meaningful Orang Asli AI inclusion therefore requires simultaneous investment in people's capabilities and the responsiveness of the technological systems they encounter.

8. Future Research

The proposed Culturally Responsive AI Literacy and Agency Framework is conceptual and has not yet undergone empirical validation. Its dimensions and propositions should therefore be treated as theoretically derived constructs that require systematic examination across diverse Orang Asli communities. Future research should adopt a staged programme that moves from contextual exploration to measurement development, structural validation and cross-community assessment.

Phase 1 — Qualitative Exploration. The first phase should examine whether the proposed dimensions correspond with the lived experiences, priorities, concerns and technological practices of Orang Asli communities. Semi-structured community interviews, focus groups, observations, participatory workshops and expert consultations could be used to identify culturally specific meanings, refine conceptual boundaries and reveal dimensions not sufficiently captured by the present framework. Participatory approaches are particularly important to ensure that framework refinement is undertaken with communities rather than merely about them.

Phase 2 — Instrument Development. Findings from the qualitative phase should inform the development of measurable constructs and questionnaire items for each framework dimension. Expert validation, content-validity assessment, cognitive interviewing and pilot testing should be conducted to evaluate item clarity, cultural appropriateness, linguistic accessibility and conceptual relevance.

Phase 3 — Quantitative Validation. Larger-scale studies should then examine the framework's psychometric and structural properties through exploratory factor analysis, confirmatory factor analysis, reliability assessment, convergent validity, discriminant validity and structural equation modelling. This phase would permit empirical testing of the proposed relationships leading toward AI agency.

Phase 4 — Cross-Community Validation. Subsequent studies should assess whether the framework operates consistently across different Orang Asli groups and geographical contexts. Comparative analyses should also examine variations associated with age, education, gender, location, digital experience and occupational context.

Significantly, validation should not assume that a single universal model will function identically across all Orang Asli communities. The framework should remain sufficiently flexible to accommodate linguistic, cultural, geographic and socioeconomic diversity while preserving its central emphasis on capability, cultural responsiveness, sovereignty, collective participation and AI agency as shown in Figure 4.

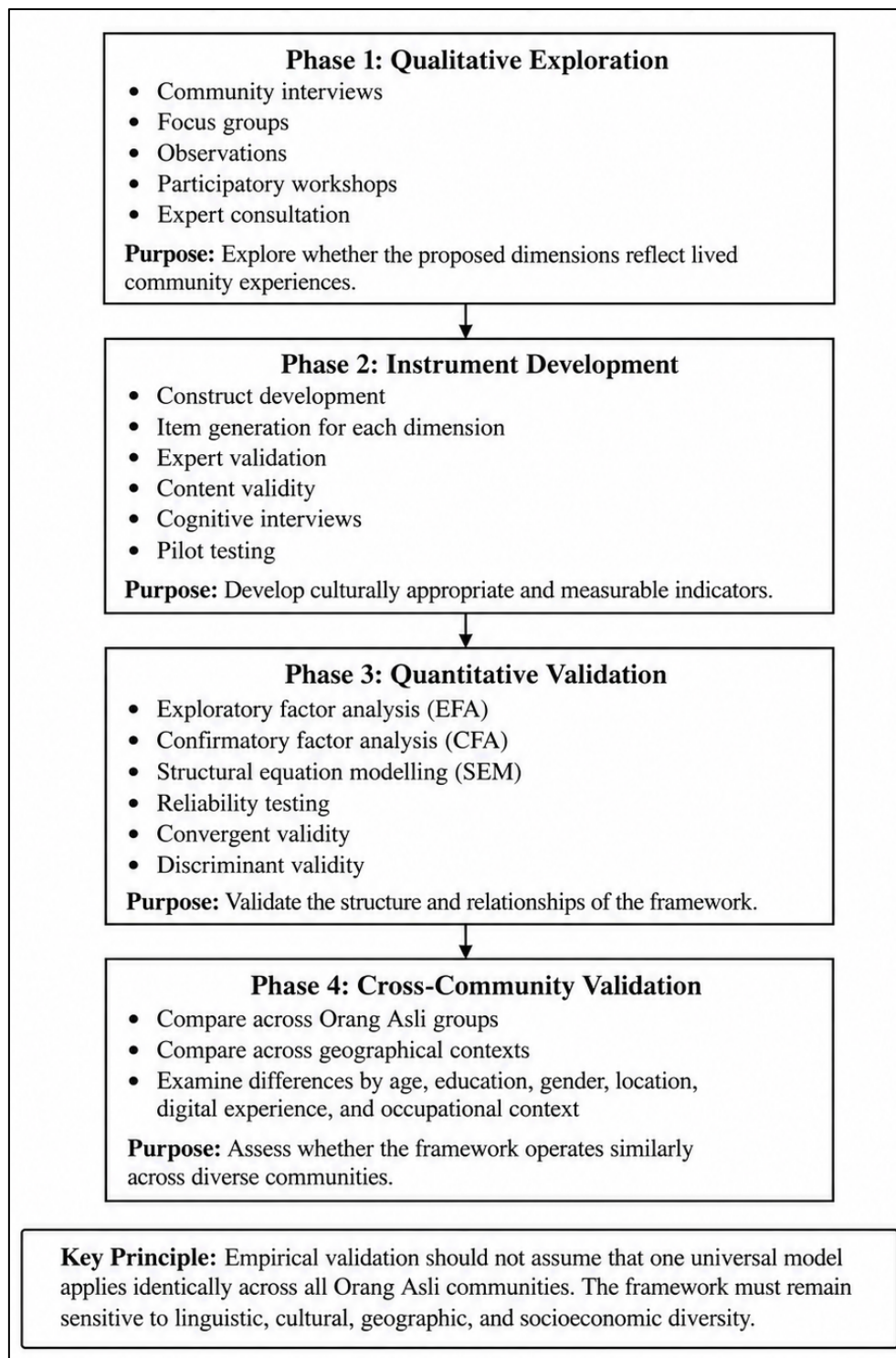


Fig. 4. Future Research for Validating the Culturally Responsive AI Literacy and Agency Framework

9. Conclusion

The emerging AI divide cannot be understood through digital access or technical literacy alone. As AI becomes increasingly embedded in education, communication, public services, employment and everyday decision-making, meaningful inclusion requires more than connectivity or the ability to operate digital tools. This paper therefore conceptualises a progression that begins with digital foundations, develops through AI awareness, functional AI literacy, critical AI literacy and ethical AI

literacy and is further strengthened by cultural relevance, trust and safety, Indigenous knowledge and data sovereignty besides community capability, ultimately culminating in AI agency. The endpoint of this progression is not simply greater AI adoption. Rather, it is the capacity of Orang Asli individuals and communities to understand AI, evaluate its outputs, utilize it for meaningful purposes, question its assumptions, protect culturally significant knowledge, reject inappropriate applications and determine how AI should serve community priorities. In this sense, AI agency represents a higher-order form of inclusion grounded in capability, cultural legitimacy, collective participation and meaningful control. The proposed framework provides a foundation for future theory development, measurement, empirical validation, culturally responsive AI education, Orang Asli digital policy besides human-centred AI design. Its central implication is that inclusive AI futures should not be measured by whether Orang Asli communities enter AI ecosystems, but by whether they possess the capabilities, rights and agency to shape those ecosystems on their own terms.

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