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RESEARCH ARTICLE

# REVISED Developing Researchers' Competencies through CARE–KNOW–DO and upSKILL.map, aligned with EU and UNESCO Priorities

[version 4; peer review: 4 approved]

Previously titled: "Developing Researchers' Competencies through CARE–KNOW–DO and upSkill.Map, aligned with EU and UNESCO Priorities"

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## Abstract

### Background

In an era of interlinked global challenges, researchers are expected to combine disciplinary excellence with socially relevant solutions. Existing competency frameworks recognise transversal skills but tend to prioritise employability and career management, treating skills as value-neutral and positioning sustainability, equity, and justice at the margins. This creates skills mismatches and leaves many researchers underprepared for work aligned with the UN-SDGs and Horizon Europe priorities.

### Methods

This Phase-1 study within the European METEOR project develops upSKILL.map and provides in-context pilot validation for eco-outwards research careers. Grounded in the CARE–KNOW–DO principles, the

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| | 1 | 2 | 3 | 4 |
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tool articulates eight competency domains (8Cs) integrating values, knowledge, and action. A phase-appropriate cohort of 40 researchers completed the 8Cs self-assessment and wrote reflective think pieces, generating a mixed-methods dataset for contextual psychometric analysis and thematic enquiry.

**Results**

Exploratory factor analysis, reliability testing, expert review, and user feedback converge on a five-factor descriptive clustering explaining 75.7% of variance as a baseline, clustering the 8Cs into: Responsible policy-engaged research; Collaborative inclusive leadership; Interdisciplinary networked innovation; Societal impact methodologies; and Resilient capacity development. Datasets highlight an aspiration–practice gap between collaborative, transformative goals and uneven institutional support.

**Conclusion**

Conceptually, the study advances a shift from "competency-as-performance" to "competency-as-worldview", articulating the eco-researcher identity where technical expertise is inseparable from commitments to sustainability, equity, and justice. This represents one valued orientation among legitimate research identities; fundamental science and curiosity-driven inquiry remain equally valid. Methodologically, it provides context-bound evidence that upSKILL.map can function as a low-cost diagnostic tool combining psychometric analysis with qualitative insight. Organisationally, it outlines how doctoral schools and researcher development leads can use the five-factor clustering to identify gaps and design targeted interventions for local and global agendas. Exploratory findings are based on a single institution and a small, self-selected cohort, so further multi-institutional confirmation is needed before high-stakes or sector-wide use.

**Keywords**
Researchers' Competencies, Doctoral Education, CARE-KNOW-DO framework, EU Agenda, UNESCO SDGs

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**REVISED** **Amendments from Version 3**

Version 4 follows peer-review acceptance and introduces only minor changes for consistency and accuracy; no analyses, findings, or interpretations have changed. Corrections fall into three areas.

Typographical and formatting consistency. Minor typographical errors were corrected. The rating-scale anchors are now reported consistently across Sections 2.2 and 4.1.2. CARE–KNOW–DO is standardised to en-dashes in the body text, with previously published reference titles left as originally published. Recruitment figures are reported consistently throughout, and SDG numbering and the framework labels were aligned across sections.

References. In-text citations and the reference list were reconciled: a missing reference was added, and a few references not cited in the text were removed.

Descriptive accuracy. A small number of descriptions and cross-references were corrected for accuracy (including the Box reference in the Factor 4 discussion).

**Any further responses from the reviewers can be found at the end of the article**

## 1. Introduction

### 1.1 The imperative for a new research paradigm

We live in an era defined by the growth of global polycrises: climate breakdown, intensified inequalities, and technological disruption (Lawrence *et al*., 2024; Chankseliani, 2023). The researcher's role is changing in many fields. For many research careers, producing disciplinary excellence in isolation is no longer sufficient (Yudkevich *et al*., 2020; Baker & Powell, 2024). Researchers increasingly need transversal competences—skills with knowledge and values applicable across sectors and occupations—to drive socially relevant, sustainable, and transformative solutions (UNESCO, 2017; United Nations, 2023; Martínez & Tejero, 2025; Okada 2025b). Figure 1 presents the Eco-Outwards Competency Framework operationalised by upSKILL.map, which addresses these gaps through CARE–KNOW–DO principles underpinning 8Cs competencies clustered into five capability factors.

According to the European Framework for Skills, Competences, Qualifications and Occupations (ESCO, 2025), transversal competences function as foundational infrastructure: *"Transversal knowledge, skills and competences are relevant to a broad range of occupations and economic sectors. They are often referred to as basic skills, foundational competences or soft skills, the cornerstone for the personal development of a person. Transversal knowledge, skills and competences are the building blocks for developing the 'hard' skills and competences required to succeed on the labour market" (ESCO, 2025).*

Yet this definition exposes a critical gap: it treats transversal competences as isolated skills, rather than as a capability learners apply purposefully in real-world contexts. A regenerative worldview integrating technical mastery, ethical commitment, and temporal responsibility to future generations is absent from current frameworks. Although the European Commission's GreenComp framework (Bianchi *et al*., 2022) advances sustainability competence (Michel *et al*., 2023) by emphasizing systems thinking and values reflection, and ESCO's recent Green Skills initiative (2025) labels transversal competences (Taylor & Clark, 2023; Roy *et al*., 2025) for environmental behaviour, we argue that both frameworks share a fundamental limitation. Neither framework positions sustainability and equity as fundamental to researcher worldview, nor do they articulate researchers' ethical commitments to future generations, with emphasis on futures literacy. The researcher remains positioned as a qualified professional within present-day labour markets, not as a competent transformative agent with ethical commitments across generations. This requires recognition of an essential distinction: intergenerational responsibility is ethical, not transactional.

### 1.2 Existing frameworks

Major competence architectures for researchers (Table 1), including ResearchComp (European Commission, 2025a), the Researcher Development Framework (RDF) (Vitae, 2025), and the OECD Core Competency Framework (OECD, 2019), have advanced recognition of transferable skills and professional development across research careers. These frameworks define structured domains of competence intended to support employability, career progression, and research effectiveness (Lee *et al*., 2022; Garcia *et al*., 2017). Yet, they largely prioritise career management and performance, often treating skills as value-neutral capabilities that can be applied independently of ethical, ecological, or social commitments (Mulder, 2014; Patel *et al*., 2020). Crucially, sustainability and equity are not positioned as foundational, non-negotiable dimensions of research practice (Wiek *et al*., 2011).

In both the Vitae RDF and EU ResearchComp, references to sustainability focus primarily on financial viability, infrastructure continuity, and individual work–life balance rather than ecological integrity or social justice (European

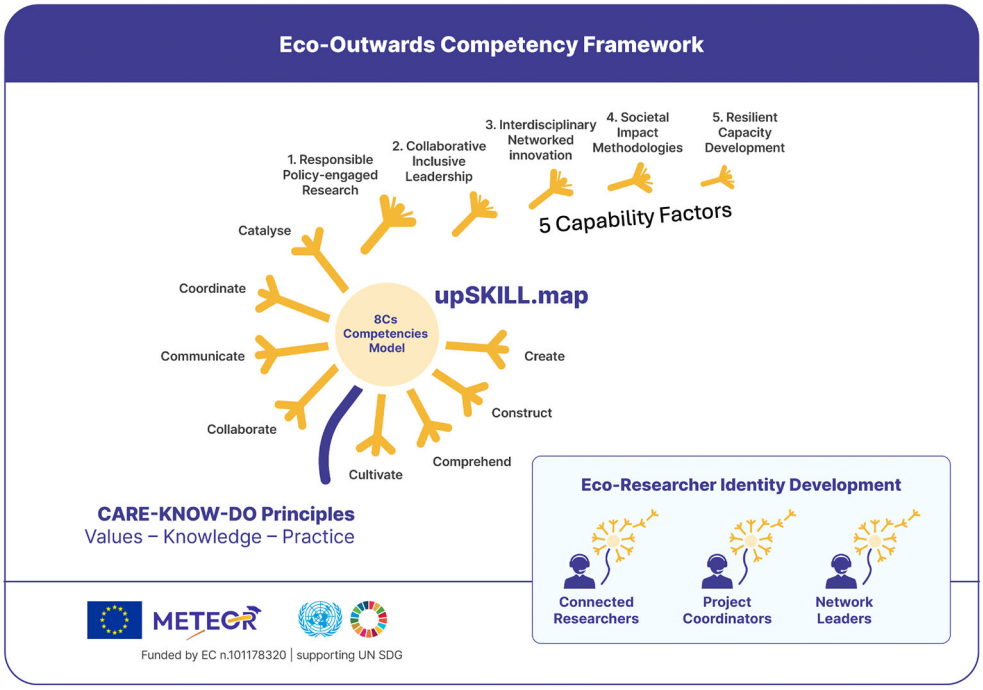



**Figure 1. Eco-outwards competency framework operationalised by upSKILL.map: from the 8Cs competency domains to five capability factors across three researcher profiles, grounded in CARE–KNOW–DO principles.** Source: Okada (2025a).

**Table 1. Comparative analysis of researcher competency frameworks.**

| Feature | ResearchComp (EU) | Vitae RDF (UK) | OECD Core Framework | upSKILL.map: Eco-researcher |
|---|---|---|---|---|
| Primary Focus | Employability & Career | Development and Leadership | Skills for Labor Market | Sustainable & Responsible Research |
| Sustainability | Peripheral (Self-org.) | Implicit/Peripheral | Absent | Foundational (Central Pillar) |
| Equity & Justice | Absent | Peripheral | Absent | Foundational (Central Pillar) |
| Theoretical Model | Competency-as-Performance | Competency-as-Performance | Human Capital | Competency-as-Worldview |
| Key Dimensions | Cognitive & Interpersonal | 4 Domains | Cognitive & Socio-Emotional | CARE–KNOW–DO principles |
| Target Outcome | Competitive Workforce | Professional Excellence | Economic Productivity | Planetary & Public Good |

Commission, 2025a, p. 27; Vitae, 2025, p. 15). The RDF refers to "strengthening organisational funding sustainability" and contributing to the financial sustainability of projects and programmes, equating sustainability with institutional continuity. Similarly, ResearchComp emphasises sustainable work practices, funding models, and resource management. This framing reflects an efficiency-oriented interpretation in which sustainability serves to maintain research productivity and institutional stability, rather than to guide ethical responsibility toward planetary and societal wellbeing.

The Vitae RDF, ResearchComp and the OECD Core Framework address purposes distinct from those of the eco-outwards framework — respectively, researcher career development and leadership, employability across European research labour markets, and cross-occupation skills comparison. The eco-outwards framework articulates one legitimate professional orientation and worldview among many. upSKILL.map is designed for researchers whose work engages with societal, policy, or sustainability challenges — a constituency currently underserved by existing frameworks — and is not a universal model for all research careers. Disciplinary excellence, curiosity-driven inquiry, and fundamental

science remain equally valid research identities, each shaped by different developmental priorities that fall outside the scope of this paper.

Building on CARE–KNOW–DO (Okada & Gray, 2023; Okada, 2025b), this paper introduces the eco-outwards research framework that underpins upSKILL.map. The framework integrates values (CARE), knowledge (KNOW), and action (DO) across eight competency domains, positioning sustainability not as an operational requirement but as an ethical and epistemic commitment to planetary stewardship, intergenerational responsibility, and social justice. While sustainability scholarship distinguishes between short-term resilience and long-term ecological stewardship (Summers *et al*., 2017; Wilson & Wu, 2017), this temporal–ethical dimension is largely absent from dominant competence models — a gap upSKILL.map is designed to address.

This reframes researcher competence as the ethical stewardship of values, knowledge, and practice across time, shifting from a performance-based construct toward a worldview-oriented orientation in which sustainability, equity, and systems awareness function as organising principles rather than peripheral skills. Employability is not displaced but repositioned: the eco-researcher integrates technical expertise with social justice and systems-level responsibility (Boni & Gasper, 2012; Cole *et al*., 2023; Owen *et al*., 2022), aligning researcher development with the UN Sustainable Development Goals and Horizon Europe's responsible research and innovation agenda.

Building on these foundations, this paper introduces an empirically derived five-factor structure and diagnostic instrument (upSKILL.map), enabling individual- and programme-level identification of aspiration–practice gaps related to sustainability, equity, and regenerative futures. In doing so, it proposes eco-social responsibility — understood here as the integration of environmental sustainability and social equity — as a foundational organising principle for researcher development rather than an optional extension of existing competency models.

### 1.3 Research approach, aims, and research questions

Realising this reframing empirically and at scale requires understanding how institutional conditions enable or constrain eco-outwards competency development. This Phase-1 study focuses strategically on doctoral and early-career researchers at a single institution — The Open University, UK — as a situated, in-depth case.

This design prioritises contextual depth over breadth. Doctoral and early-career researchers represent critical leverage points where professional identity is most malleable, making them ideal subjects for studying how institutional conditions shape emerging research culture. A single-institution focus enables detailed documentation of barriers and enablers that multi-institutional surveys cannot capture.

The eco-outwards competency framework (Table 2, Figure 1) rests on four interrelated constructs: principles, worldview, competencies, and a diagnostic instrument. **CARE–KNOW–DO** provides the epistemological foundation, integrating values (CARE), knowledge (KNOW), and practice (DO) as inseparable dimensions of researcher competence. This worldview shapes the **eco-researcher** — a professional orientation extending beyond disciplinary and institutional boundaries toward planetary stewardship and socio-environmental justice.

The **8Cs model** operationalises the eco-researcher identity into eight practice domains (Collaborate, Communicate, Cultivate, Construct, Comprehend, Create, Coordinate, Catalyse). As the findings in §4 show, these eight domains cluster empirically into **five capability factors**: Responsible policy-engaged research; Collaborative inclusive leadership; Interdisciplinary networked innovation; Societal impact methodologies; and Resilient capacity development. **upSKILL.map** assesses researchers' current position across the 8Cs, surfaces aspiration–practice gaps, and supports targeted development at individual and programme level.

This paper reports a Phase-1 contextual pilot validation of the upSKILL.map instrument within the European Commission (EC)–funded METEOR project (Methodologies for Teamworking in Eco-outwards Research), using a design-based research approach. The study aims to: (1) examine the structural coherence of the 8Cs competency model; (2) identify latent competency factors prioritised by researchers and associated aspiration–practice gaps; and (3) generate diagnostic evidence on institutional conditions that support or constrain eco-outwards competencies.

This Phase-1 study is designed to generate, in preparation for Phases 2 and 3: (1) actionable institutional insights; (2) a foundation for multi-institutional networked research across institutions, sectors, and nations. Two mechanisms justify this approach: **career-stage leverage** (doctoral training embeds eco-outwards competencies at a formative stage; and **methodological replicability** (careful psychometric analysis at realistic scale, provides a model that under-resourced institutions can adapt without requiring equivalent infrastructure).

**Table 2. Eco-Outwards Research Framework: *components, types, and functions.*** Source: Okada (2025b).

| Component | Type | Function |
|---|---|---|
| Eco-outwards research framework | Theoretical framework — conceptual reference | Supports researcher competence as eco-social stewardship shaping eco-researcher identity |
| CARE–KNOW–DO principles | Foundation — epistemological basis | Integrates values, knowledge, and practice as inseparable dimensions of researcher competence |
| Eco-researcher identity | Professional orientation construct — profile | Consolidates researcher orientation toward planetary stewardship and socio-environmental responsibility |
| 8Cs competencies model | Competence model — practical reference | Defines eight core competencies-as-worldview required for eco-researcher development |
| Five capability factors | Capabilities — capability structure | Enables eco-researcher development across five dimensions, empirically derived higher-order clusters of the 8Cs |
| upSKILL.map | Diagnostic instrument — assessment tool | Operationalises the 8Cs and five factors to assess aspiration–practice gaps and support eco-researcher development |

The paper addresses two research questions:

**RQ1** *(conceptual/structural)*: How coherent and robust is the 8Cs competency model as an expression of the eco-researcher identity?

**RQ2** *(empirical/priorities)*: What latent competency factors emerge from researchers' responses, and which eco-outwards competencies and institutional barriers do they prioritise?

Rather than testing specific interventions, this Phase-1 study generates diagnostic insights institutions can use to embed sustainability, equity, and social responsibility into doctoral training and researcher development programmes. §2 details the theoretical foundations of this framework; §3 describes how it was developed and tested; §4 and 5 report and interpret the findings.

## 2. Development of the upSKILL.map instrument

### 2.1 Theoretical foundations

The upSKILL.map instrument demonstrates the CARE–KNOW–DO principles by integrating six complementary theoretical principles from diverse theories that together provide a robust and values-led foundation for doctoral education and researcher professional development (Table 3). These principles are distinct but mutually reinforcing, addressing metacognition, competence, transformation, responsibility, sustainability, and equity.

Table 3's six references map to CARE–KNOW–DO principles: CARE anchors emotional/values-based engagement (self-assessment, transformative learning, equity); KNOW builds evidence/systems competency (RRI, sustainability science); DO drives implementation (action/equity). This structures the 8Cs domains, which Exploratory Factor Analysis (EFA) condenses into five emergent factors (§4).

#### *2.1.1 Self-Assessment and self-regulated learning*

Self-Assessment Theory (Hattie & Timperley, 2007) and Self-Regulated Learning (Zimmerman, 2002; Zimmerman & Schunk, 2011) position learners as active agents in their development. upSKILL.map builds on these by enabling researchers to evaluate their skills, prioritise areas for growth, and reflect on progress over time. This scaffolds self-efficacy, feedback use, and goal-directed monitoring, turning reflection into actionable strategies for professional growth.

#### *2.1.2 Competency-based and developmental models*

Competency-Based Education (Eraut, 1994; Mulder, 2014) views competence as the integration of knowledge, skills, values, and attitudes in real contexts. Developmental frameworks such as Vitae RDF, and EC ResearchComp highlight progression from novice to expert. The upSKILL.map instrument adopts and values these approaches but extends them beyond short-term employability or immediate task performance. It combines staged ratings with the CARE–KNOW–DO principles to support a holistic and authentic approach that integrates motivation, understanding, and practice:

**Table 3. Theoretical Frameworks and their Contribution to *upSKILL.map*.**

| Theoretical References | Core Concepts | How It Underpins *upSKILL.map* |
|---|---|---|
| 1. Self-Assessment and Self-Regulated Learning | Self-efficacy, goal setting, metacognition | Scaffolds reflective, self-directed growth through prioritisation and rating tools |
| 2. Competency-Based and Developmental Models | Holistic capability, researcher identity, progression | Structures the 8Cs and CARE–KNOW–DO model as developmental pathways |
| 3. Transformative Learning | Critical reflection, perspective shift, worldview | Supports values clarification and societal role development |
| 4. Responsible Research and Innovation (RRI) | Inclusion, reflexivity, public accountability | Anchors Catalyse and CARE domains in anticipatory, and ethical engagement |
| 5. Sustainability Science and Regenerative Education | Systems thinking, action competence, futures literacy, regenerative principles | Aligns development with SDGs and future-focused interdisciplinary research, and positions researchers as co-creators of sustainable futures |
| 6. Equity-Oriented Development | Capabilities, justice, wellbeing | Promotes inclusion, supports researchers from and working within marginalised regions, and challenges deficit models |

- CARE: values and engagement (Communicate, Collaborate, Cultivate)
- KNOW: knowledge and analysis (Comprehend, Construct, Coordinate)
- DO: application and impact (Create, Catalyse).

By connecting competence with purpose, expertise, and practice, upSKILL.map reconceives researcher development as more than skill acquisition, emphasizing the cultivation of worldview capabilities and sustainable-futures identities within authentic, holistic contexts (Gardner, 2011; Perkins, 2010).

#### *2.1.3 Transformative learning*

Transformative Learning Theory (Chen *et al.*, 2020; Cranton, 2006; Mezirow, 1997) emphasises reflection and perspective change. upSKILL.map incorporates this by embedding indicators of justice, equity, and sustainability, encouraging researchers to question assumptions and align professional identities with wider societal commitments.

#### *2.1.4 Responsible Research and Innovation (RRI)*

RRI (Stilgoe *et al.*, 2013; von Schomberg, 2013) reframes research as anticipatory, reflexive, inclusive, and responsive. upSKILL.map integrates these dimensions by encouraging open science, stakeholder engagement, and ethically informed decision-making. RRI thus provides both an ethical compass and a practical framework for aligning innovation with societal needs.

#### *2.1.5 Sustainability science*

Sustainability Science (Langston, 2021; UNESCO, 2018; Wiek *et al.*, 2011) identifies competencies such as systems thinking, action competence, and future literacy. Futures literacy (UNESCO, 2020) enables researchers to anticipate, imagine, and prepare for multiple possible futures, moving beyond prediction to cultivate adaptive capacity in uncertainty. Regenerative principles (Sterling, 2021; van den Berg & Wals, 2022) shift the paradigm from "doing less harm" to actively restoring and revitalizing socio-ecological systems. Together, these inform the instrument's emphasis on interdisciplinarity, scenario planning, and readiness to act for transformative change, equipping researchers to address complex, interconnected global challenges and co-create sustainable, just futures (Piccardo *et al.*, 2022).

#### *2.1.6 Equity-oriented models of development*

Equity-focused perspectives (McAlpine & Amundsen, 2018; Raffaghelli *et al.*, 2020; Walker & Boni, 2006) emphasise epistemic justice, wellbeing, and the inclusion of diverse voices. upSKILL.map enacts these by providing activities that (1) surface diverse knowledge systems valuing plural knowledge systems, (2) supporting underrepresented groups in mapping their competencies and aspirations, and (3) fostering collaborative reflection through transdisciplinary "thinking pieces," allowing participants to co-construct knowledge, and challenge deficit models of researcher development.

Together, these six principles link individual agency to collective responsibility, connecting technical capability with ethical purpose, sustainability and equity (Abdelghaffar & Eid, 2025) in researcher development. They foreground participatory science with and for society, supporting iterative listening, feedback and co-design across the research process, and position upSKILL.map to help eco-outwards researchers address complex, interconnected global challenges (Langston, 2021; UNESCO, 2017; Wiek *et al.*, 2011).

### 2.2 Instrument constructs

upSKILL.map translates these theoretical references into a practical developmental self-assessment instrument. It is organised around the 8Cs model (Table 4), aligned with the CARE–KNOW–DO principles as described in §2.1.2. The model specifies eight domains of capability, each defined by four indicators (32 in total). This design produces both individual profiles and collective patterns of researchers' capability.

This mapping illustrates how the instrument's design is not arbitrary but systematically integrates metacognition, progression, transformation, responsibility, sustainability, and equity. Each 8C is grounded in one or more of the six principles; together, the 8Cs express how eco-researchers 'care' about societal challenges, 'know' systems and evidence, and 'do' transformative work.

### 2.3 Instrument overview

The upSKILL.map is a diagnostic and developmental instrument that operationalises the 8Cs competencies model and five capability factors to assess eco-researcher capability and identity formation. Grounded in the CARE–KNOW–DO principles, it integrates quantitative self-assessment with structured qualitative reflection to examine capability development, professional priorities, and alignment between researcher aspirations and enacted practice.

As shown in Figure 2, the instrument is organised into three sequential parts, intentionally scaffolded so that each part builds on the previous: Part-1 establishes the contextual and experiential foundation; Part-2 maps capability against that foundation; and Part-3 invites researchers to interpret, reflect on, and integrate both into a coherent professional orientation narrative.

#### *Part-1: Context and practice*

Part-1 grounds the instrument in each participant's lived research context before any capability rating takes place. It opens with demographic data (continent, ethnicity, gender, disability, field, role stage, and experience) to support analysis of diversity, inclusion, and institutional representativeness. Participants then identify their current involvement in research impact areas — including social innovation products, major grant-funded initiatives, contributions to global challenges such as the SDGs, and policy or regulatory influence — establishing the professional terrain within which their capabilities will be assessed.

Two open questions deepen this contextualisation: participants describe the issue or challenge in their doctoral or current research and reflect on who contributes to the framing of research priorities — embedding reflexivity on power and agenda-setting from the outset. A further question invites participants to describe their views on AI for Responsible Research and Innovation, including current or planned practices, tools, and support needs. This is intentionally positioned as a contextual and cross-cutting question rather than a discrete competency item: AI literacy is conceived throughout the instrument as an enabling capability that can amplify all eight competency domains, not as a standalone competency reducible to a single indicator among the 32. A closing question asks which research skills, including AI, participants wish to develop further — connecting Part-1 directly to the capability assessment that follows.

#### *Part-2: 8Cs competency model*

Building on the contextual foundation established in Part-1, Part-2 presents a structured quantitative self-assessment of 32 competency indicators derived from the 8Cs model, organised across the eight competency domains (Collaborate, Communicate, Cultivate, Construct, Comprehend, Create, Coordinate, Catalyse). Participants rate each indicator on a

**Table 4. Mapping the 8Cs to Theoretical Concepts (*Superscript numbers refer to Sections 2.1.1 to 2.1.6*).**

| 8C Domain | Core Competency Constructs | Key Concept |
|---|---|---|
| **Collaborate**<br>*Support interdisciplinary research partnerships* | Interdisciplinary teamwork,<br>Team contribution,<br>Conflict resolution,<br>Inclusive diversity | Metacognition[1],<br>Interdisciplinarity[2],<br>Inclusion[6],<br>Agency[6] |
| **Communicate**<br>*Share accessible and intercultural knowledge* | Science communication,<br>Network building,<br>Policy engagement,<br>Intercultural dialogue | Feedback use[1],<br>Reflexivity[4],<br>Perspective shift[3] |
| **Cultivate**<br>*Nurture lasting, inclusive professional growth* | Mentoring support,<br>Community participation,<br>Event organisation,<br>Reflective Practice | Self-efficacy[1],<br>Capabilities approach[6],<br>Wellbeing[6] |
| **Construct**<br>Build evidence-based, participatory solution | Research design,<br>Literature synthesis,<br>Methodological innovation,<br>Ethical practice | Knowledge integration[2],<br>Systems thinking[5],<br>Ethics[5] |
| **Comprehend**<br>*Critically understand diverse perspectives* | Systems analysis,<br>Evidence evaluation,<br>Information synthesis,<br>Creative problem-solving | Systems thinking[5],<br>Critical reflection[3],<br>Cognitive regulation[1] |
| **Coordinate**<br>*Lead inclusive, engaging, and committed teams* | Resource management,<br>Priority balancing,<br>Risk management,<br>Team leadership | Developmental progression[2],<br>Leadership[2],<br>Anticipation[4] |
| **Create**<br>*Develop responsible research and innovation* | Interdisciplinary links,<br>Innovative thinking,<br>Knowledge cocreation,<br>Adaptive research | Creativity[3],<br>Boundary-crossing[5],<br>Innovation competence[2] |
| **Catalyse**<br>Drive sustainable change for the common good | Open research,<br>Policy innovation,<br>Community empowerment,<br>Impact evaluation | Public value[4],<br>Ethics[5],<br>Societal responsibility[6] |

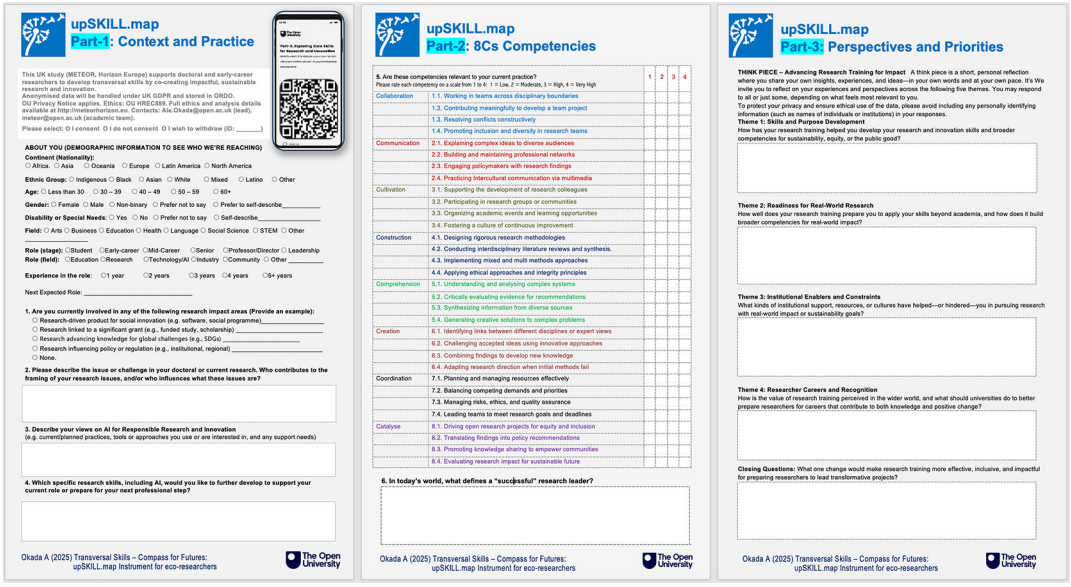



**Figure 2. The upSKILL.map self-assessment instrument (Qualtrics interface), showing Part-1: Context and Practice, Part-2: 8Cs Competencies, and Part-3: Perspectives and Priorities.** Accessible via QR code on mobile, tablet, or computer. Source: Okada, 2025a.

four-point developmental scale (1 = low, 2 = moderate, 3 = high, 4 = very high) according to its relevance to their current practice. It is important to note that Part-2 ratings reflect participants' perceived relevance of each indicator to their current practice, rather than an objective assessment of demonstrated competence. A closing open question — "In today's world, what defines a successful research leader?" — bridges the structured rating into the reflective inquiry of Part-3, inviting participants to articulate their own normative vision of research excellence before reflecting on their own development.

***Part-3: Perspectives and priorities***

Part-3 consists of a qualitative think piece structured around five thematic prompts that progressively move from individual capability through institutional context to professional orientation: (1) Skills and Purpose Development — how training has shaped skills, values, and alignment with sustainability and the public good; (2) Readiness for Real-World Research — how well prepared researchers feel to apply their skills beyond academia to address societal challenges; (3) Institutional Enablers and Constraints — what kinds of support, resources, or cultures have helped or hindered research with real-world impact; (4) Researcher Careers and Recognition — how research training is perceived in the wider world and what universities should do to better prepare researchers for careers contributing to knowledge and positive change; and a Closing Question asking what one change would make research training more effective, inclusive, and impactful for transformative projects. Together these prompts function as a narrative inquiry space (Clandinin & Connelly, 2000), capturing how capability is interpreted and enacted across career stages and institutional contexts.

The instrument is designed for completion in approximately 20–30 minutes and is administered via Qualtrics, allowing asynchronous participation on mobile devices, tablets, or computers. By combining contextual mapping, structured capability assessment, and reflective inquiry, upSKILL.map generates a coherent, multi-layered evidence base for analysing researcher capability, aspiration–practice alignment, and eco-researcher development across disciplines and institutional contexts.

### 2.4 Embedding power and agenda-setting reflexivity

Critically, upSKILL.map does not present societal challenges as pre-defined problems for researchers to "solve." Instead, participants reflect on how research issues and priorities are developed—for example, through engagement with partners, funders, communities, local policy contexts, or global agendas.

Participants are prompted to consider the issues or challenges in their doctoral or current research, focusing on who shapes the framing of research questions and who influences what these issues become. They can illustrate this with examples such as:

- Research-driven products for social innovation (e.g., patents, software, social programmes);
- Research linked to significant grants (e.g., funded studies, scholarships);
- Research advancing knowledge for global challenges (e.g., Agenda 2030);
- Research influencing policy or regulation (e.g., institutional or regional);
- or none of the above.

This design embeds reflexivity on power and agenda-setting by describing their own research and its co-definition processes, participants develop critical awareness of how priorities are negotiated with community, policy, and practitioner stakeholders.

By integrating experiential accounts, structured self-assessment, and reflective narratives, upSKILL.map operationalizes core competencies for eco-outwards research, emphasizing researcher agency, participatory engagement, epistemic justice, equity, and shared agenda-setting.

## 3. Methodology

This study employed a multimethod approach, combining design-based research (DBR; The Design-Based Research Collective, 2003; Anderson & Shattuck, 2012) to iteratively develop the upSKILL.map self-assessment instrument, with an explanatory sequential mixed-methods design in which quantitative findings informed subsequent qualitative inquiry for in-context pilot validation. This study constitutes Phase-1 of a multi-phase DBR programme; findings are therefore treated as exploratory and provisional, subject to confirmation through Phase-2 replication and instrument refinement.

### 3.1 Research design: Phase-1 study in a multi-phase programme

This three-phase programme positions Phase-1 findings within a larger transformation agenda: - Phase-1 (reported here): Establishes institutional model and generates insights about barriers and enablers at the Open University. - Phase-2 (currently underway): Tests whether Phase-1 insights replicate and adapt across two external METEOR academies (48+ participants, 1-year institutional integration). Methodological details in §3.2. - Phase-3 (planned): Multi-institutional comparative study tracking how research cultures transform toward eco-outwards paradigms, enabling regions and nations to track progress, identify bottlenecks, and learn from comparative implementation experiences. Detailed research questions and sample specifications in §5.5.

DBR (Design-Based Research Collective, 2003) was chosen for its capacity to integrate theory and practice in authentic educational contexts, allowing continuous refinement through empirical feedback and stakeholder engagement. Participants received full project information and provided written informed consent prior to engaging with the upSKILL.map instrument activities, with consent obtained through a differentiated framework allowing individuals to specify permissions. Information about the project and written informed consent were embedded within the upSKILL.map instrument activities. Ethical approval was granted by The Open University Human Research Ethics Committee. Where participants expressed interest and provided specific consent, collective attribution was offered in published outputs — including the think piece article and video clip — enacting a data sovereignty commitment in which contributors are recognised as co-producers of knowledge rather than research subjects.

The research unfolded in two iterative cycles (Figure 3):

- **Cycle 1: Co-Design and Piloting**. Target users (n = 8) reviewed the draft 8Cs competencies model and upSKILL.map instrument alongside the EU Research Competence model (EC, 2025a), EU Research Manager Competence model (EC, 2025b) and UN Sustainable Development Goals (UN, 2023). Based on feedback regarding clarity and relevance, five key adjustments were made: converting the scale to a 4-point metric, rewording seven items, restructuring domains, expanding behavioural anchors, and repositioning "Translating" to "Catalysing".

- **Cycle 2: Field Deployment and In-Context Validation**. The refined instrument was deployed across four doctoral programmes at The Open University (8 May–8 July 2025). Data included the upSKILL.map self-assessment with Likert-scale and reflective components (n = 40), follow-up interviews examining usability and relevance (n = 5), and a two-round Delphi-style consultation with six external experts. Experts evaluated item relevance, alignment, and completeness, followed by anonymised synthesis and consensus refinement. These three data sources including self-assessment, interviews, and expert consultation together supported content validity, reliability, and contextual applicability.

### 3.2 Participants and sampling

While the CARE–KNOW–DO principles are intended to inform researcher development across career stages, this Phase-1 study focuses on doctoral and early-career researchers as a critical leverage point for shaping future research culture. Recruitment for Cycle 2 was conducted within the OU's doctoral community, which comprises around 621 postgraduate research students (approximately 308 studying full-time and the remainder part-time, combining research degree study with work) and roughly 100 supervisors and Early Career Researchers (ECR).

We included supervisors and early-career researchers (ECRs) to ensure perspectives from more established and experienced researchers who coordinate, design, deliver, and support doctoral training, as well as to capture their views on the developmental needs of doctoral students and ECRs. Researchers were invited on a voluntary basis through emails circulated by the doctoral schools and the heads of faculty, who supported dissemination via internal mailing lists. These invitations outlined the study's focus on doctoral education and researchers' professional development for addressing global challenges and provided information about METEOR project, without additional incentives. Initial direct invitations yielded 10 participants (<2%). A further 30 participants were recruited voluntarily through purposive and snowball sampling across four doctoral programmes in the OU, supported by our research group and supervisor nominations from the OU's Open Societal Challenges programme, enabling the study to foreground the voices of those willing to engage in discussion of these issues. Demographic data (Table 5) (career stage, ethnicity, gender, disability, first language, knowledge field and faculty) were collected to examine inclusivity patterns, assess contextual representativeness, and enable intersectional checks.

Direct email invitations via four doctoral schools and faculty heads yielded 10 participants (<2% response rate)—a finding consistent with an aspiration–practice gap in engagement with reflective professional development, though not sufficient on its own to establish this relationship.

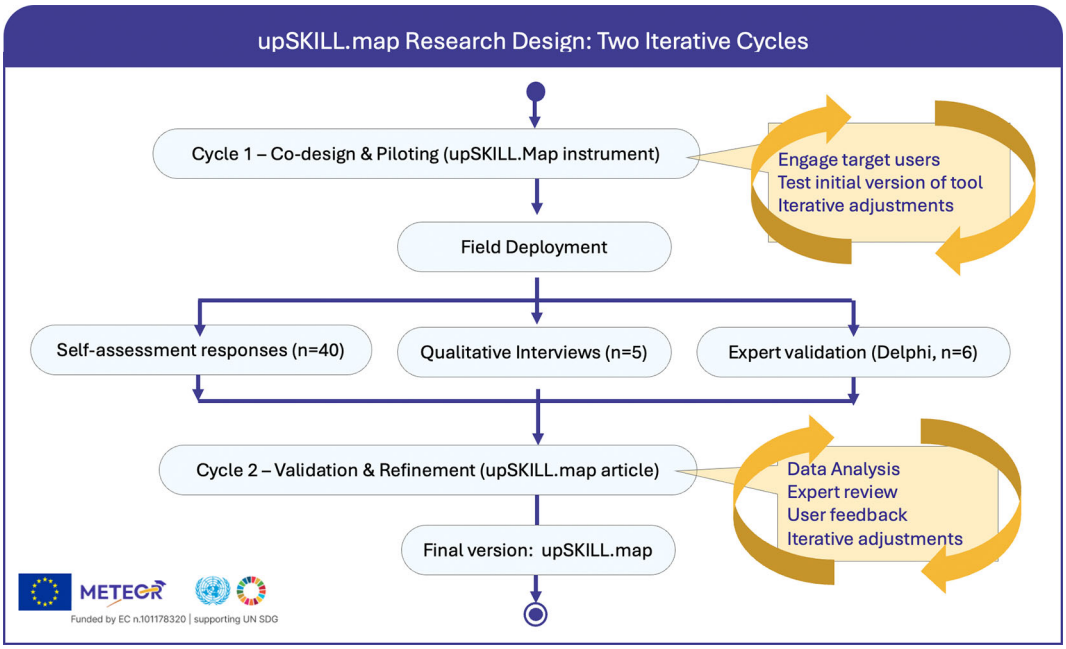



**Figure 3. upSKILL.map Phase-1 research design: two iterative DBR cycles.** Source: Okada, 2025a.

Subsequent snowball recruitment added a further 30 participants from across all four faculties, a 300% increase on the 10 initial respondents, achieved with zero incentives, rather than clustering in a single department. This cross-faculty activation suggests that eco-outwards commitment may be latent and peer-mobilizable rather than individually-driven, supporting the Phase-2 focus on institutional structures and community formation.

The study intentionally centres researchers interested in societal challenges, sustainability, global development and futures literacy themes—a constituency whose perspectives often remain marginalised in mainstream researcher-development frameworks. Within this self-selected group, the sample exhibits balanced representation across three profiles: eco-outwards research practitioners – eco-researcher (n ≈ 13), already actively engaged in global challenges; developing researchers (n ≈ 14), expressing eco-outwards commitments but reporting limited institutional support; and curious seekers (n ≈ 13), new to responsible innovation and sustainability-oriented research but motivated to develop these competencies.

**Table 5. Participant Demographics *(n = 40)*.**

| Category | Subcategory | n | % |
|---|---|---|---|
| **Current Career Stage/Role** | Research Student | 19 | 47.5 |
| | Research Associate | 3 | 7.5 |
| | Research Fellow/Lecturer | 8 | 20.0 |
| | Senior Researcher/Senior Lecturer | 5 | 12.5 |
| | Professor/Director | 3 | 7.5 |
| | Other academic role | 1 | 2.5 |
| | Director | 1 | 2.5 |
| **Nationality** | Europe | 22 | 55.0 |
| | Africa | 11 | 27.5 |
| | Other continents (combined) | 7 | 17.5 |
| **Gender** | Female | 26 | 65.0 |
| | Male | 13 | 32.5 |
| | Non-binary | 1 | 2.5 |

**Table 5.** *Continued*

| Category | Subcategory | n | % |
|---|---|---|---|
| **Age Group** | 40–49 | 13 | 32.5 |
| | 50–59 | 10 | 25.0 |
| | 30–39 | 7 | 17.5 |
| | Other/not stated | 10 | 25.0 |
| **Ethnicity** | White/Caucasian | 22 | 55.0 |
| | African/Black | 9 | 22.5 |
| | Asian | 4 | 10.0 |
| | Mixed/multiple ethnicities | 3 | 7.5 |
| | Other/not stated | 2 | 5.0 |
| **Disability/Accessibility Needs** | Yes | 7 | 17.5 |
| **Disciplinary Area** | Wellbeing, education, language | 15 | 37.5 |
| | STEM | 8 | 20.0 |
| | Arts/social sciences | 7 | 17.5 |
| | Business/marketing | 6 | 15.0 |
| | Other/not stated | 4 | 10.0 |
| **Career Aspirations** | Academic progression | 17 | 42.5 |
| | Professional/industry | 12 | 30.0 |
| | Senior research management | 7 | 17.5 |
| | Other | 4 | 10.0 |

This roughly equal distribution across experience levels strengthens analytical depth within the target population, while the voluntary, self-selected nature of participation limits generalisation to the wider researcher population. The findings therefore represent the perspectives and priorities of researchers who actively chose to engage with this agenda. As lead developer of upSKILL.map, the first author's insider position was managed through independent Delphi review, dual coding, and participant feedback loops embedded across both DBR cycles.

The study was approved by The Open University's Human Research Ethics Committee (HREC 2025–0889-4). Collecting self-assessment data in doctoral settings raises ethical concerns about deficit labelling and power relations between students, supervisors, and institutions. To minimise these risks, upSKILL.map was implemented as a semi-structured reflective activity—including a think piece for in-depth personal reflection—with all responses anonymised prior to analysis. Participants received clear information by email, including a brief explanatory summary and project website link, emphasising confidentiality, voluntary participation, and the self-reflective/developmental purpose (non-evaluative/non-scored) of the instrument. upSKILL.map was explicitly framed as a voluntary piloting activity, supported by informational materials and embedded consent procedures. All participants received copies of their individual data and a newsletter with the global study analysis. In addition, supplementary recorded interviews (n = 5) were conducted with participants who provided explicit informed consent for research and for attribution—with authorship acknowledged—in a video clip for open educational resources (OER).

### 3.3 Data analysis and open science commitments

Data analysis proceeded in two phases, combining quantitative and qualitative strands in an explanatory-sequential design.

Quantitative Analysis: Descriptive statistics and EFA were used to identify latent clusters of research competencies. The quantitative analysis provided an empirically grounded, inductive view of the competency landscape without imposing a priori structures. Sampling adequacy and factorability were checked with results indicating that the data were suitable for EFA despite the modest sample size (See §4.1).

Qualitative analysis: All 40 think pieces were analysed using a deductive–inductive thematic approach. These were independently coded by two researchers against a codebook derived from the CARE–KNOW–DO principles and the 8Cs model (deductive), with discrepancies iteratively refined through discussion of negative cases and emergent themes

(inductive), documenting decisions in an analytical audit trail. Following Braun and Clarke's (2019) reflexive thematic analysis approach, we did not calculate a κ coefficient or percentage agreement, as our focus was on rich, interpretive engagement with the data rather than quantifying coder similarity; disagreements were resolved through negotiated consensus, supporting trustworthiness and transparency. This is consistent with methodological guidance that cautions against conflating reliability with rigour in interpretive research: high κ can be achieved by narrowing codes to the point of losing conceptual richness, whereas low κ may reflect appropriate sensitivity to complexity (Braun & Clarke, 2019). AI-assisted linguistic analysis was used as a supplementary epistemic check — not to replace interpretive judgement — to surface outliers and confirm the stability of key themes across participants, interviews, and expert consultations, which were coded using the same framework (see §4.2).

Integration and meta-inference: Integration followed an explanatory-sequential logic: quantitative patterns framed the qualitative interpretations, which were then used to re-examine the findings. Joint displays aligned factor scores, self-prioritised competencies and coded narratives, so that points of agreement, complement, and disagreement could be assessed directly rather than assumed.

To contextualise statistical findings, as detailed in the instrument design (§2.3), participants were asked to indicate their involvement in research addressing global challenges—specifically, their contributions to the SDGs, advancement of knowledge toward critical problems, policy influence, and other significant pathways. Analysis of these responses, presented in Table 6 (Mechanisms of Research Impact), reveals how the 8Cs competency domains map onto authentic research practice. The five-factor structure (Table 8; Figure 4) showed broadly consistent item relevance across different career stages in this cohort. Given the heterogeneity of the sample, noticeable between-stage variation might have been expected; its absence suggests the clustering reflects a pattern that is stable enough in Phase-1 to warrant confirmatory testing at scale. Together, these quantitative, qualitative, and integrative analytical strands supported the meta-inferences that underpin the institutional recommendations in §5.5.

In line with Open Research Europe's commitment to open science (Barnes & Weller, 2017) and to advance participatory research principles embedded in our DBR approach, the full upSKILL.map instrument (items, guidance notes, and coding approach), supplementary materials, open educational resources, videos, and dataset were made available via the UK METEOR ORDO website for institutional adaptation across contexts. During the review process, preliminary findings were shared with participants through research briefs to support collaborative feedback and refinement, ensuring the development process remained iterative and co-designed.

### 3.4 Trustworthiness and limitations

Rigour was ensured through three complementary strategies. First, triangulation combined participant reflections, expert review from the Delphi consultation (Linstone & Turoff, 2002; Dalkey, 1969), and theoretical foundations mapped across the two DBR cycles, cross-validating findings and reducing single-source bias. Second, iterative DBR cycles of piloting and refinement supported credibility and confirmability throughout instrument development (Lincoln & Guba, 1985). Third, grounding upSKILL.map in international frameworks—the EU Research Competence and Research Manager Competence Frameworks (ResearchComp, EC, 2025a; RMComp; EC, 2025b) and the UN Sustainable Development Goals—strengthened both conceptual validity and applicability across diverse research contexts.

This Phase-1 study has four limitations, each acknowledged and mitigated.

Sample size. The sample (n = 40) is modest relative to large-scale validation studies; however, design-based research prioritises contextual depth over breadth (Anderson & Shattuck, 2012; detailed in §3.2). The 28-item instrument retains a participant-to-item ratio of approximately 1.4:1, below the conventional thresholds for confirmatory factor analysis (Tabachnick & Fidell, 2013; Fabrigar *et al*., 1999). The analytic implications of this ratio are addressed in §4.1.3, and Phase-2 multi-institutional replication (target n > 200) is designed to remedy the sample-size constraint.

These indicators are broadly consistent with the conditions under which de Winter *et al*. (2009) showed that EFA can yield reliable results for N below 50, corroborating evidence from independent sources is discussed in §4.2, and; full psychometric indicators are reported in Table 7. Accordingly, all findings should be treated as exploratory and institution-bound, not intended to support generalisation beyond the Open University context until multi-site replication is complete in Phases 2 and 3.

Single-institution focus. The study is grounded in the Open University's organisational culture and disciplinary ecology, which limits cross-institutional transferability at this stage. However, the sample achieved disciplinary diversity across the university spectrum, providing insights into how different research traditions understand and prioritise eco-outwards competencies. This single-institution baseline serves as a reference model for Phase-2 multi-site replication across a

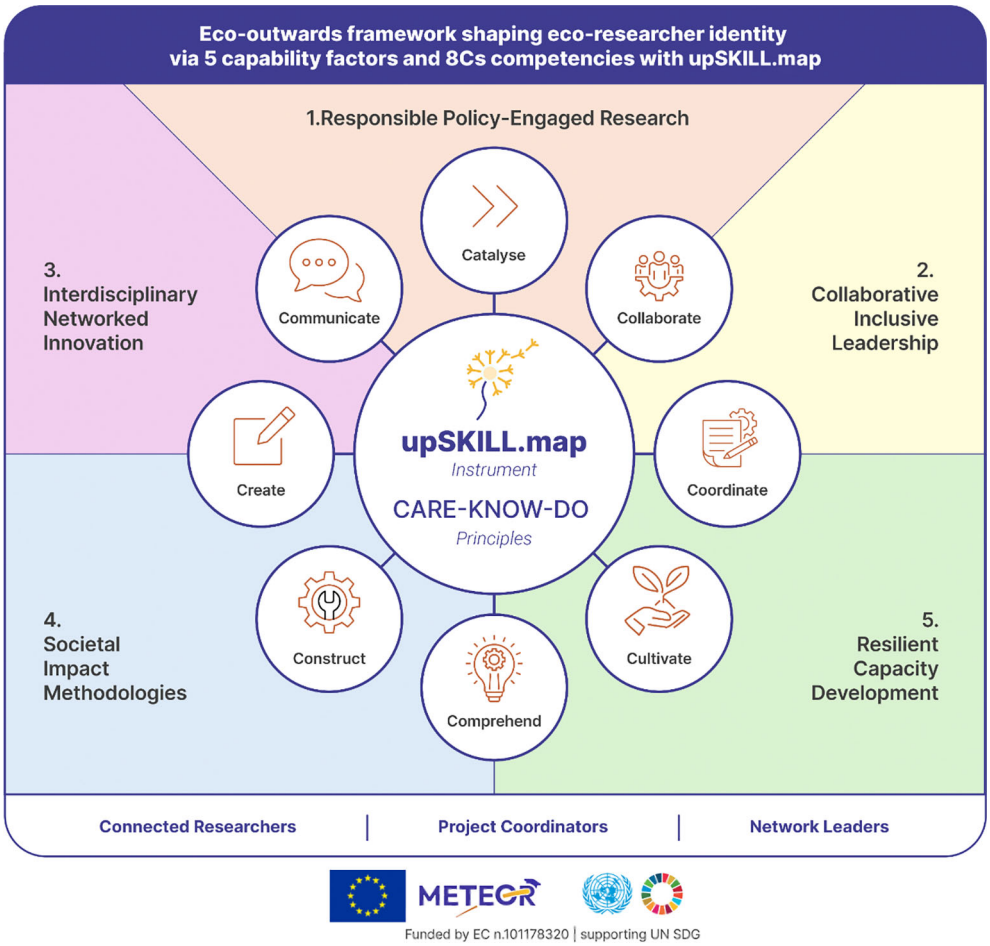



**Figure 4. Eight competency domains (8Cs), based on CARE–KNOW–DO principles, clustering into five capability factors of eco-outwards researcher development.** Source: Okada, 2025a.

minimum of three European partner institutions and Phase-3 sector-wide deployment, at which point confirmatory factor analysis (CFA) and cross-cultural measurement invariance testing will be conducted.

Supervisor network bias. All non-doctoral researchers in the sample were supervisors or recruited via supervisor networks, potentially biasing perspectives toward institutional leadership views. This is acknowledged and shapes interpretation of findings about institutional barriers and enablers; Phase-2 recruitment will explicitly target non-supervisory research staff to address this imbalance.

Social desirability bias. Self-reported data carries an inherent risk of socially desirable responding. This was mitigated through: (a) voluntary participation with no institutional incentives; and (b) open-ended think piece questions that generated rich qualitative evidence revealing institutional constraints alongside individual aspirations, reducing the risk that responses reflect only idealised self-presentation.

The factor loadings and ratings reported here reflect how participants positioned themselves in relation to each competency indicator — that is, the degree to which they perceived each item as relevant to their current practice. These findings reflect perceived relevance grounded in reflective experience and forward-looking aspiration, rather than individual performance. The distinction between perceived relevance and demonstrated competence will be addressed through expanded measurement approaches in the next phase of instrument development.

Taken together, the breadth of disciplinary experience in Phase-1, the coherent psychometric properties of the instrument, and the transparent multi-phase validation trajectory (Boateng *et al.*, 2018) provide a robust foundation for testing generalisability at scale. The limitations identified here are not disqualifying; they define the scope of Phase-1 claims and the agenda for Phases 2 and 3.

## 4. Findings

This section reports what the Phase-1 data can and cannot show. The quantitative analyses (n = 40) yield a tentative five-factor structure and item-level priority patterns; the qualitative analyses surface how a self-selected cohort of Open University researchers interprets and enacts eco-outwards competencies. Findings are therefore descriptive of this cohort and instrument-internal rather than generalisable, and the theoretical implications are taken up separately in §5.

### 4.1 RQ1: Structural context and coherence of the 8Cs model

Quantitative and qualitative data were analysed in an explanatory-sequential design (Creswell & Plano Clark, 2018). EFA first identified the underlying factor structure of the 28-item instrument; qualitative interview data (n = 5) and expert consultation (n = 6, Delphi-style) subsequently triangulated and refined the factor labels and interpretations. This approach ensured that quantitative statistical patterns were grounded in lived researcher experience and aligned with international researcher-development standards.

#### *4.1.1 Context: Research on global challenges*

Participants were asked within the upSKILL.map instrument (see §2.3: Instrument Structure and Data Availability section for the complete questionnaire instrument) to indicate their current involvement in research addressing global challenges. This contextual item, administered alongside the 32 8Cs skill-rating items (Part 2), served to map how the competency model relates to authentic research practice. Specifically, participants selected from a set of research impact activities aligned with sustainability and societal benefit:

- Contributing to the Sustainable Development Goals (SDGs),
- Advancing knowledge to address critical global challenges,
- Influencing policy or regulation,
- Pursuing major grant-funded initiatives,
- Engaging in other significant research pathways
- No current involvement in the above

**Table 6. Mechanisms of research impact.**

| Impact Mechanism | % (n = 40) | Doctoral students' and ECRs' Example Projects/Themes | No. Students (out of 23) |
|---|---|---|---|
| (1) Advancing knowledge to address global challenges | 22/40 = 55.0% | Disaster risk reduction; decolonising death & grief studies; OpenSTEM Africa; genetics; climate change education; sustainability | 13 |
| (2) Social innovation products | 21/40 = 52.5% | AI apps for migrants; dialogic teaching; digital/ accessible platforms; teacher development; inclusive STEM | 10 |
| (3) Shaping policy or regulation | 17/40 = 42.5% | Workplace reproductive rights; DfE/Welsh policy; democracy; transport accessibility; AI/education regulation | 7 |
| (4) Major grant-funded initiatives | 15/40 = 37.5% | CONNECT 2030 (EU); GCRF/British Academy; UKRI Future Leaders; Fleming Fund; Horizon Europe | 8 |
| (5) Other | 7/40 = 17.5% | Ethics in digital design; green entrepreneurship; curriculum coding/ computational thinking; teaching professional development | 3 |
| (6) None of the above | 8/40 = 20.0% | (No current involvement in above mechanisms) | 7 |

This contextual question investigates the paradigm shift described in the Introduction: it grounds the 8C model in evidence of how researchers engage with impact, equity, and sustainability in real-world practice. Engagement with impact was reported across a range of contexts. While all participants were based within a single UK university, the settings in which they carried out their research were global, spanning Sub-Saharan Africa, Europe, Latin America, and Asia. Examples included inclusive literacy strategies in Africa, participatory climate heritage projects in Europe, assistive AI tools for migrants in Latin America, and genomic data-sharing for public health in Asia. The distribution of responses reveals the diversity of mechanisms through which our sample demonstrates eco-outwards research engagement.

The 40 participants represented a diverse range of disciplinary areas within the institution. They identified six main mechanisms of research impact (Table 6): advancing knowledge to address global challenges (55%), creating social innovation products (52.5%), shaping policy and regulation (42.5%), contributing to major grant-funded initiatives (37.5%), and, to a lesser extent, other areas (17.5%) or none of the above (20%). More than half described innovating beyond traditional research outputs, and over a third were engaged in externally funded projects.

Although situated within one institution, the diversity of participants' fields, regions of research practice, and thematic commitments provides insight into how researchers navigate impact at the intersection of academic rigour and social relevance. Cross-cutting themes included digital transformation, inclusive development, co-creation with communities, and open innovation for sustainable change. Most projects were aligned with Quality Assurance (QAA, 2020), the SDGs (UNESCO, 2017)—particularly SDG 4 (Quality Education), SDG 10 (Reduced Inequalities), and SDG 17 (Partnerships for the Goals)—underscoring the strong outward-facing orientation of the sample.

#### *4.1.2 Overview: Descriptive statistics*

Descriptive statistics characterised perceived relevance of each 8Cs competency item and informed subsequent psychometric checks (item screening, correlations, EFA, see Appendix 1–3).

Following screening, four poorly performing items were removed (4.1 Designing rigorous research methodologies; 5.1 Understanding/analysing complex systems; 7.2 Balancing competing demands/priorities; 5.4 Generating creative solutions to complex problems). In the retained 28-item solution, **communalities ranged from 0.24–0.82 (M = 0.52, SD = 0.16)**, indicating moderate–strong factor representation while preserving specificity—ideal for Phase-1 contextual analysis.

Participants rated the relevance of a range of research-related competencies to their current roles using a 1–4 scale (low, moderate, high, very high). The most highly valued competencies were explaining complex ideas to diverse audiences (M = 3.58), building professional networks (M = 3.60), applying ethical principles (M = 3.62), and critically evaluating evidence (M = 3.65). These underscore the centrality of evidence evaluation, ethics, and professional networking in participants' work. Most competencies scored above moderate relevance (M > 3.0), indicating broad alignment with daily responsibilities. However, some—including engaging policymakers (M = 2.95), leading research teams (M = 2.88), and practising intercultural communication (M = 2.78)—were seen as less relevant, with greater variation across responses. This points to uneven applicability depending on role and suggests a need for more targeted development in leadership, policy engagement, and cross-cultural competencies to fully support diverse career pathways.

In terms of item-level correlation and scale coherence, the item-level Pearson correlation analysis for the 8Cs competency set (N = 40; 28 items) revealed consistently strong within-domain correlations, particularly in clusters such as collaboration and communication ($r \approx 0.65–0.85$). For instance, "Working in teams across disciplinary boundaries" and "Contributing to develop a team project" exhibited a correlation of approximately 0.80, consistent with the internal coherence of these constructs.

Moderate to high cross-domain correlations ($r \approx 0.40–0.70$) were also observed, suggesting that research-related competencies are perceived holistically. This pattern provides preliminary evidence supporting the internal coherence of the instrument in capturing integrated professional skillsets. While several inter-item correlations exceeded 0.75, indicating a high degree of internal consistency ($\alpha = 0.963$), this also flags a minor risk of redundancy—an acceptable trade-off in early-stage instrument development where content breadth is essential.

Mann–Whitney U tests comparing Research Students with Research Fellows/Lecturers, Senior Researchers/Senior Lecturers, and Professors/Directors revealed no statistically significant differences across any of the 28 competency items (all $p > 0.05$), with one near-borderline result noted for competency_1 in the Senior Researcher/Senior Lecturer comparison ($p = 0.075$) (See Appendix 4). This pattern of non-significance is consistent with broadly shared perceptions of research competency relevance across career stages (Brown *et al.*, 2024), though small subgroup sizes limit statistical

power and warrant interpretive caution. Nonetheless, the absence of systematic divergence across groups supports the cross-stage applicability of the 8Cs framework, providing a consistent foundation for the exploratory factor analysis reported below.

#### *4.1.3 Findings: Exploratory factor analysis and technical evaluation*

Although the sample size (n = 40) is below conventional recommendations for exploratory factor analysis, its use is a deliberate methodological choice for Phase-1, context-bound validation within a design-based research framework, which prioritises theoretical coherence and contextual sensitivity over statistical generalisation.

Psychometric adequacy was first assessed to confirm the suitability of the dataset for exploratory factor analysis. As shown in Table 7, the correlation matrix was suitable for exploratory data reduction: the Kaiser–Meyer–Olkin measure indicated acceptable sampling adequacy (KMO = 0.732), Bartlett's test of sphericity was significant ($\chi^2(378) = 1{,}152.93$, $p < .001$), internal consistency was high (Cronbach's $\alpha = 0.963$), and total variance explained was substantial (75.69%), a level consistent with a well-structured instrument-development pilot.

The factor representation (mean 5.0 items per factor) was adequate for interpretation. The participant-to-item ratio (1.4:1) is below conventional thresholds for confirmatory validation (Tabachnick & Fidell, 2013; Fabrigar *et al*., 1999) and is the reason the solution is treated as descriptive rather than confirmatory (§4.1.3). This framing — separating adequately supported diagnostic elements from those requiring larger-sample confirmation — is offered as a methodological template for Phase-1 pilots and small-cohort studies where confirmatory thresholds cannot be met but exploratory clustering is still informative.

Principal Component Analysis (PCA) with Varimax rotation and Kaiser normalisation (Tabachnick & Fidell, 2013; Kaiser, 1974) was used as the primary extraction method, consistent with the Phase-1 aim of variance-maximising descriptive data reduction during instrument development (Gorsuch, 1983; Velicer & Jackson, 1990; Costello & Osborne, 2005). Following the four-item screening reported in §4.1.2, the Kaiser (eigenvalue > 1) criterion returned a five-component solution that converged in eight iterations (Table 8), accounting for 75.69% of total variance:

- Component 1 (Responsible policy-engaged research): 19.83%
- Component 2 (Collaborative inclusive leadership): 16.23%
- Component 3 (Interdisciplinary networked innovation): 14.47%
- Component 4 (Societal impact methodologies): 13.47%
- Component 5 (Resilient capacity development): 11.69%

Component loadings ranged from 0.476 to 0.825, with all items loading above 0.45 on their primary component, supporting differentiation and interpretability of the clustering.

**Table 7. Psychometric Indicators (n = 40).**

| Metric | Value | Interpretation |
|---|---|---|
| Kaiser–Meyer–Olkin (KMO) | 0.732 | Acceptable sampling adequacy |
| Bartlett's Test of Sphericity | $\chi^2(378) = 1152.93$, $p < .001$ | Correlation matrix factorable |
| Cronbach's α (28 items) | 0.963 | Excellent internal consistency |
| Total Variance Explained | 75.69% | Phase-1 descriptive data reduction (PCA), extraction-method-dependent |
| Participant-to-item ratio | 1.4:1 | Acceptable for exploratory, context-bound validation |
| Mean items per factor | 5.0 | Adequate factor representation |

Because the Kaiser rule is known to over-extract at small sample sizes (Zwick & Velicer, 1986), three convergent diagnostics were applied to interrogate the component count. The scree plot (Appendix 1) showed a pronounced elbow after Component 1, with eigenvalues declining smoothly through Components 2–7 without a secondary inflection; by the Cattell (1966) criterion this supports a one- to two-component solution. Parallel analysis (Horn, 1965; Glorfeld, 1995), comparing observed eigenvalues against the 95th percentile of 1,000 Monte Carlo simulations of random data, found that only Component 1 exceeded the random-data threshold (actual eigenvalue = 14.698 vs. random 95th percentile = 3.330); Components 2–5 did not exceed their corresponding thresholds. A common-factor robustness check using Principal Axis Factoring (PAF) with Oblimin rotation converged with the PCA on four of five components (Responsible Policy-Engaged Research, Interdisciplinary Networked Innovation, Societal Impact Methodologies, and Resilient Capacity Development replicated with stable item composition), while Collaborative Inclusive Leadership showed method-dependence, its items redistributing across clusters under oblique rotation. The corresponding fifth PAF factor returned a rotation sum of squared loadings of 1.77 — an order of magnitude smaller than the remaining four (6.7–10.1).

**Table 8. Exploratory factor analysis revealing 5 clusters integrating 8C skills.**

| Rotated Component Matrix[a] | | | | | |
|---|---|---|---|---|---|
| | Component | | | | |
| | 1 | 2 | 3 | 4 | 5 |
| **1: Responsible Policy-Engaged Research** | | | | | |
| @5.2.Critically evaluating evidence for recommendations | .825 | | | | |
| @4.4.Applying ethical approaches and integrity principles | .808 | | | | |
| @7.3.Managing risks ethics and quality assurance | .782 | | | | |
| @8.3.Promoting knowledge sharing to empower communities | .745 | | | | |
| @2.3.Engaging policymakers with research findings | .661 | | | | |
| @8.2.Translating findings into policy recommendations | .633 | | | .579 | |
| @2.4.Practicing intercultural communication via multimedia | .476 | | | | |
| **2: Collaborative Inclusive Leadership** | | | | | |
| @2.1.Explaining complex ideas to diverse audiences | | .816 | | | |
| @1.1.Working in teams across disciplinary boundaries | | .753 | | | |
| @1.2.Contributing meaningfully to develop a team project | | .683 | | | |
| @1.4.Promoting inclusion and diversity in research teams | | .609 | | | |
| @7.4.Leading teams to meet research goals and deadlines | | .503 | | | |
| @5.3.Synthesizing information from diverse sources | | .483 | | | |
| **3: Interdisciplinary Networked Innovation** | | | | | |
| @2.2.Building and maintaining professional networks | | | .823 | | |
| @6.3.Combining findings to develop new knowledge | | | .721 | | |
| @6.2.Challenging accepted ideas using innovative approaches | | | .679 | | |
| @6.4.Adapting research direction when initial methods fail | | | .672 | | |
| @3.2.Participating in research groups or communities | | | .572 | .484 | |
| @6.1.Identifying links between different disciplines or expert views | | | .524 | | |
| @3.3.Organizing academic events and learning opportunities | | | .494 | | |
| **4: Societal Impact Methodologies** | | | | | |
| @4.2.Conducting interdisciplinary literature reviews and synthesis | | | | .748 | |
| @4.3.Implementing mixed and multimethods approaches | | | | .609 | |
| @8.1.Driving open research projects for equity and inclusion | | | | .595 | |
| @8.4.Evaluating research impact for a sustainable future | .519 | | | .576 | |

**Table 8.** *Continued*

| Rotated Component Matrix[a] | | | | | |
|---|---|---|---|---|---|
| **5: Resilient Capacity Development** | | | | | |
| @1.3.Resolving conflicts constructively | | .479 | | | .750 |
| @3.4.Fostering a culture of continuous improvement | | | | | .744 |
| @3.1.Supporting the development of research colleagues | | | | | .724 |
| @7.1.Planning and managing resources effectively | | | | .562 | .639 |

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
[a]Rotation converged in 8 iterations.

Taken together, these diagnostics indicate that only Component 1 is robustly supported as an independent latent dimension at n = 40, a pattern consistent with a general-factor-plus-specific-facets organisation (Reise *et al.*, 2010; Rodriguez *et al.*, 2016) in which a strong eco-outwards orientation accounts for approximately half of item variance, with four specialised subsidiary clusters and one weaker, method-sensitive dimension. Despite this statistical caution, the five-component PCA solution was retained as the primary Phase-1 descriptive result on three interpretive grounds:

a) it aligns with the theoretically-derived 8Cs structure (§2.2);

b) it produces results consistent with the independent qualitative analysis — both the Delphi-style expert consultation (n = 6) and the thematic analysis of researcher think pieces (n = 40) produced five interpretively coherent clusters matching the PCA components (§4.2), providing triangulation support that statistical diagnostics alone cannot establish; and

c) it provides the organising structure for the institutional-planning framework in §5.5 and Table 10.

The five-component structure is therefore presented as a theoretically-informed descriptive clustering and a baseline specification for Phase-2 confirmatory refinement, not as a validated latent-factor model. Phase-2 will test this baseline against competing structural specifications (single-factor, bifactor, hierarchical) with a pre-registered multi-institutional sample (n > 200; see §5.4). This positioning is consistent with the DBR programme's iterative logic, in which Phase-1 pilot clustering surfaces candidate structures that Phase-2 confirmatory testing subsequently refines or restructures at scale.

### 4.2 RQ2: Prioritised eco-outwards competency factors

The five-factor structure identified through exploratory factor analysis was used to organise the qualitative phase: factor scores informed the selection of illustrative cases, guided the development of the coding frame, and shaped the clustering of themes around responsible research, collaboration, networking, methodological breadth, and resilience. Quantitative patterns showed that all five factors scored above the midpoint, with Factor 1 (responsible and policy-engaged research) highest and Factor 5 (resilient capacity development) lowest — suggesting strong ethical awareness but weaker support for sustaining work in complex contexts. Together, quantitative and qualitative strands revealed an aspiration–practice gap and highlighted resilience as a priority area for development. Qualitative narratives were then used to interpret and name each factor through a CARE–KNOW–DO lens: examining how researchers emotionally engage with challenges (CARE), understand systemic barriers (KNOW), and enact change (DO) within institutional contexts. This iterative movement between quantitative structure and qualitative depth supported the interpretability of both the instrument and its theoretical framing at Phase-1, pending Phase-2 confirmatory testing.

#### Factor 1: Responsible Policy-Engaged Research

EFA grouped a cluster of seven interrelated skills: critical evaluation, ethical principles, risk management, community empowerment, policymaker engagement, evidence-to-policy translation, and multimodal intercultural communication. With regard to research connected to policy (see Table 6). Three skills clustered together, indicating that policymakers, communities, and researchers must be engaged throughout the research process through knowledge exchange, research agenda co-creation, and research-informed recommendations. Importantly, "evidence-to-policy translation" is not conceptualised as a linear, post-research activity, but as an iterative and negotiated process embedded in contexts of policy design, use, and implementation.

Thematic analysis of open-ended responses (Box 1) captured six perspectives from students, researchers, and academic leaders. A recurring theme was the *aspirational–practical gap*: the tension between strong commitments to responsible research and the real-world challenges of implementation. Many students expressed motivation to pursue societal impact, ethical integrity, and

policy relevance—echoing the skills identified in this factor. For example, they called for greater industry collaboration, critical engagement with emerging ethical issues such as AI, and research that delivers tangible long-term benefits.

For example, statements such as "I have always struggled to align my work with the public good" were coded as tensions between aspiration and application, contributing to the theme "Aspirational vs practical gap" within Factor 1.

However, students frequently reported insufficient training and limited opportunities to develop the skills needed to translate research into policy or community outcomes (*Skills and Training Deficits, Theme 2*). Across stakeholder groups, there was consensus on the importance of societal benefit and research integrity, yet frustrations emerged regarding institutional barriers such as restricted funding and rigid structures that inhibit applied engagement (*Institutional Constraints, Theme 3*). Senior researchers emphasised the ethical imperative to ensure research contributes beyond academia (*Ethical Imperative, Theme 4*), while calls for reform highlighted the need to embed real-world engagement more centrally within doctoral education (*Systemic Change Needed, Theme 5*), supported by participants' accounts of continuous policy engagement and participatory approaches with policymakers and communities (Theme 6).

Convergence between the quantitative and qualitative strands was strong for this factor. The three highest-loading items in Factor 1 — critical evaluation (.825), ethical principles (.808), and risk management (.782) — aligned with the three most recurrent qualitative themes: ethical imperative (Theme 4), aspirational–practical gap (Theme 1), and institutional constraints (Theme 3), each surfacing across all three career-stage groups. One divergence is worth noting: while the EFA positions intercultural communication as the lowest-loading item in this factor (.476), qualitative narratives rarely named it as a development priority, suggesting it may not belong in this cluster and warrants item-level review in Phase-2.

### Factor 2: Collaborative Inclusive Leadership

EFA identified a cluster of six interconnected skills centred on the ability to communicate complex ideas to diverse audiences, contribute meaningfully within research teams, and foster inclusive environments. These interpersonal and organisational competencies are critical for enabling productive and equitable collaboration in research contexts. Factor 2 received consistently high ratings, especially from students and lecturers, indicating that inclusive practices are both recognised and valued. However, participants also reported limited time for reflection, unequal decision-making power, and a lack of recognition for collaboration in promotion systems—echoing calls for systemic change to embed and reward inclusive leadership.

Thematic analysis (Box 2) reinforced the centrality of these competencies but revealed gaps in practice. Students placed high importance on communication and peer networks, as both qualitative and quantitative data revealed (Theme 1), yet

**Box 1. Thematic analysis linked to Factor-1 Responsible Policy-Engaged Research.**

| Themes | Most Representative Quote | Stakeholder |
|---|---|---|
| 1. Aspirational vs. Practical Gap | "I have always struggled to align my work with the public good or sustainability as it's been so 'blue skies'." | Leadership [L5] |
| 2. Skills and Training Deficits | "Structured training in leadership or policy engagement is more limited … others lack the mentoring or applied contexts to do so confidently." | Research Student [DS1] |
| 3. Institutional Constraints | "Without external funding or pre-established relationships … it is very difficult to pursue real world social impact." | Research Fellow [R11] |
| 4. Ethical Imperative | "When research on inclusion does not translate into real-world impact, it contributes to marginalisation and discrimination." | Research Student [DS6] |
| 5. Systemic Change Needed | "Embed real-world engagement into the core of doctoral education not as an add-on, but as a fundamental part of research design." | Research Student [DS5] |
| 6. Continuous policy engagement and participatory approaches | My role demands deep comprehension of sustainable development frameworks, green economy trends, and start-up dynamics. I continuously engage in reading, research synthesis, and environmental scanning including policy frameworks and participatory regulation | Research Associate [DS4] |

described persistent collaborative skills gaps (Theme 2) and institutional recognition barriers (Theme 3) that undermine their ability to contribute fully. Crucially, the high ranking of communication skills does not imply that the research itself lacks relevance or societal demand. On the contrary, participants explicitly framed societal impact as a non-negotiable component of modern scholarship. Aspirations for embedding inclusion and sustainability into research design (Theme 4) often remained unfulfilled, while wellbeing through connection (Theme 5) was seen as both a personal necessity and an institutional responsibility. The barrier is not a lack of meaningful research to share, but rather an opportunity-based gap where institutional structures have not yet caught up to researchers' aspirations to be "accountable to wider society.

Participants possess the motivation to bridge research-practice gaps but lack the institutional space and time to develop these competencies confidently. While informal networks offer some support, the current framework often leaves students without the mentoring or applied contexts needed to translate complex ideas for a global job market.

Convergence between the quantitative and qualitative strands was strong for this factor. The highest-loading item — explaining complex ideas to diverse audiences (.816) — aligned directly with Theme 1 (Communication and Peer Networks), reinforcing that communication is both statistically central to this factor and experientially prioritised by researchers at every career stage. The remaining high-loading items — working in teams across disciplinary boundaries (.753) and contributing meaningfully to team projects (.683) — converged with Theme 2 (Collaborative Skills Gaps) and Theme 3 (Institutional Recognition Barriers), where participants described motivation to collaborate but insufficient formal structures to support it. One divergence is worth noting: wellbeing (Theme 5) emerged as a recurring qualitative concern — particularly among doctoral students describing stress, isolation, and the need for peer community — yet no item in the current 28-item scale directly captures researcher wellbeing or mental health support. This suggests wellbeing is an emergent participant priority that sits adjacent to collaborative leadership in lived experience but is not yet represented in the instrument's item set and warrants consideration in Phase-2 item development.

### Factor 3: Interdisciplinary Networked Innovation

Exploratory Factor Analysis (EFA) identified a cluster of capabilities combining creative problem-solving, adaptability, and the sustained relationship-building needed to advance research agendas in complex and evolving contexts. These skills underpin cross-disciplinary collaboration and the ability to navigate emerging challenges. Factor 3 received moderate scores overall, with senior researchers rating these competencies more highly than students, likely reflecting experience-based confidence. Students reported restricted access to networks and difficulties engaging in intersectoral collaboration, underscoring the need for institutional strategies that democratise access to professional communities and innovation spaces.

**Box 2. Thematic analysis linked to Factor-2 Collaborative Inclusive Leadership.**

| Themes | Most Representative Quote | Stakeholder |
|---|---|---|
| 1. Communication and Peer Networks | "Communication and collaboration. These are essential not only for effective teamwork but also for translating research into meaningful outcomes and engaging with diverse stakeholders." | Research Fellow (R8) |
| 2. Collaborative Skills Gaps | "We also need more practical training - hands-on training... Skills such as research and analytical skills, academic writing and communication, time and project management, networking and collaboration." | Research Student (DS3) |
| 3. Institutional Recognition Barriers | "There is currently no way to account for how individual researchers and the ways they think impact their lab. I have a colleague who has contributed to nearly every research group informally, but she is not valued." | Senior Researcher (SR4) |
| 4. Inclusive Practice Aspirations | "Embed inclusion and sustainability into the structure of research design—not as optional themes, but as core values. A successful doctorate today should not only advance knowledge but make that knowledge usable, accessible, and accountable to wider society." | Research Student (DS1) |
| 5. Wellbeing Through Connection | "One important point we haven't discussed is mental health and well-being. Many students face stress, isolation, or uncertainty during their PhD... Institutions should prioritise well-being support, foster peer communities, and normalise help-seeking." | Research Student (DS2) |

Thematic analysis of qualitative responses (Box 3) revealed strong proactive engagement with innovation and networking among students and early career researchers (ECRs). Activities included integrating AI and other digital tools into research workflows, building cross-disciplinary partnerships, organising academic events, and connecting with both academic and non-academic stakeholders. There was consistent demand for structured, credit-bearing opportunities in areas such as grant writing, professional exchanges, and industry or NGO collaborations, with a view to producing tangible and demonstrable outcomes.

Senior researchers emphasised the importance of sustained interdisciplinary dialogue and regular exchanges across departments, while institutional leaders focused on the strategic cultivation of external networks and the careful management of risks associated with openness in a challenging global climate, particularly regarding equity, diversity, and inclusion (EDI).

Convergence between the quantitative and qualitative strands was strong for this factor. The three highest-loading items — building and maintaining professional networks (.823), combining findings to develop new knowledge (.721), and challenging accepted ideas using innovative approaches (.679) — aligned with the three most prominent qualitative themes: Professional Network Building, Cross-Disciplinary Collaboration, and Creative Problem-Solving, each reported consistently across doctoral students, early-career researchers, and research fellows.

A notable emergent finding from the contextual research data is that AI tool use appeared as a cross-cutting capability across career stages — cited by doctoral students, research associates, and research fellows in relation to networking, knowledge synthesis, and creative problem-solving. Significantly, AI was not assessed as a standalone competency within the 8Cs instrument, reflecting its design intention: AI literacy is conceived as an enabling capability that cuts across and amplifies all eight competency domains rather than constituting a discrete skill. This finding suggests that a

**Box 3. Thematic analysis linked to Factor-3 Interdisciplinary networked innovation.**

| Theme | Most Representative Quote | Stakeholder |
|---|---|---|
| AI Integration and Digital Innovation | "Yes, I integrate AI tools into my research to enhance productivity, deepen analysis, organize data, and improve text quality. I use tools such as ChatGPT, Grammarly, Notion AI, Slack, Trello, Padlet, Copilot, Consensus, IRaMuTeQ, among others." | Research Fellow (R8) |
| Cross-Disciplinary Collaboration | "Skills: create research outputs (e.g. workflows, datasets); communicate (e.g. writing tutorials and articles); collaborate (working with biologists and computer scientists)." | Research Student (DS13) |
| Professional Network Building | "Skills such as research and analytical skills, academic writing and communication, time and project management, networking and collaboration, teaching and presentation skills, and adaptability and career planning are key for doctoral completers." | Research Student (DS3) |
| Grant Writing and Funding | "More hard skills (technologies, methodologies, techniques); a set of tangible outcomes beyond passing a viva and a thesis: publishing paper(s), grant writing, project management, budgeting, teaching duties, running conferences." | Research Fellow (R7) |
| Industry and Real-World Partnerships | "Universities can better support career development by embedding practical training, creating stronger networks with industry and NGOs, and recognising non-traditional pathways as valid. PhD research can have tremendous societal impact when aligned with urgent challenges." | Research Associate (R1) |
| Creative Problem-Solving | "I develop innovative lithium separation technologies, so Creating and Collaborating are the main 8C skills... training opportunities and support from my line manager has been crucial to learn and thrive in this new research area." | Research Associate (R3) |
| Event Organization and Leadership | "I also contributed to the organisation of a large-scale conference which led to organising a post-graduate conference at the institution – all of which developed leadership skills and experience, offering a useful skillset within academia and beyond." | Research Fellow (R4) |
| International and Global Networking | "Having the opportunity to conduct part of my doctoral programme abroad was transformative. It gave me a global perspective on education and encouraged me to engage more deeply with international debates on global issues." | Research Fellow (R8) |

dedicated cross-cutting AI dimension — framed as augmentation of eco-outwards practice rather than a ninth competency — warrants consideration in Phase-2 instrument development and curriculum design.

Overall, these findings indicate that while researchers at all stages recognise the value of innovation and networking, opportunities to develop these capabilities (Nussbaum, 2011) are often self-initiated or externally driven rather than embedded in core doctoral training. Embedding structured, well-supported pathways for professionalisation—paired with formal recognition of achievements—would strengthen capacity for innovation, adaptability, and engagement across career stages.

### Factor 4: Societal Impact Methodologies

EFA identified a cluster representing methodological breadth—ranging from interdisciplinary literature synthesis to mixed and multimethods application—with a strong emphasis on equity, inclusion, and sustainability. Rather than positioning impact as a post hoc outcome, this construct situates research within societal, environmental, and policy contexts, linking methodological choices to co-creation, participation, and reflexive evaluation of impact. In doing so, it connects interdisciplinary inquiry with tangible societal and environmental benefits, underscoring the potential of research to achieve meaningful impacts beyond academia.

Factor 4 scored well overall; however, findings revealed a persistent gap between the value placed on these skills and their consistent application in practice. Disciplinary silos, insufficient incentives, and the complexity of evaluating socially embedded impact remain significant barriers, reflecting Horizon Europe's observation that interdisciplinarity is essential yet under-supported (European Commission, 2023).

Thematic analysis of qualitative responses (Box 4) revealed widespread ambition—particularly among students—to engage in interdisciplinary and societally engaged research that transcends traditional boundaries. Participants emphasised the importance of participant-led methods, cross-sector collaboration, and open research practices as means of working with communities and stakeholders across the research lifecycle, rather than informing them only at later stages. However, barriers emerge at multiple levels: students encounter siloed training and limited exposure to cross-field collaboration; mid-career researchers face workload imbalance and resource constraints; and senior academics point to the absence of institutional structures that systematically enable interdisciplinary and societally embedded initiatives.

Across stakeholders, there was clear recognition of the importance of embedding inclusion and sustainability into research design, strengthening cross-disciplinary collaboration, and ensuring research outputs deliver real-world benefits. Participants emphasised the value of diverse team experiences, internships, and industry or NGO partnerships to bridge disciplinary divides and enhance impact. Convergence between the quantitative and qualitative strands was strong for this factor. The three highest-loading items — conducting interdisciplinary literature reviews and synthesis (.748), implementing mixed and multimethods approaches (.609), and driving open research projects for equity and inclusion (.595) — aligned with the three most prominent qualitative themes in Box 5: Mixed-Methods and Methodological Breadth, Equity, Inclusion and Sustainability Focus, and Cross-Disciplinary Collaboration, each surfacing across doctoral students, mid-career researchers, and senior academics.

A cross-factor permeability finding is worth noting: environmental and social impact themes appeared prominently in Box 4 narratives — with participants framing impact as inseparable from methodological choices — yet the EFA also cross-loads impact evaluation onto Factor 1 (.519) alongside its primary Factor 4 loading (.576).

Overall, the findings suggest a shared commitment to interdisciplinary, socially responsible research, but also a structural deficit in the conditions needed for it to thrive. Addressing entrenched silos, funding gaps, and the lack of formalised pathways for collaboration is identified by participants as a key condition for enabling researchers to fully realise the societal and environmental potential of research competencies.

### Factor 5: Resilient Capacity Development

EFA identified a cluster of adaptive capacities essential for overcoming challenges, sustaining continuous improvement, and supporting colleagues. This construct spans time and resource management, conflict resolution, adaptability under uncertainty, and building a supportive research culture. Factor 5 was the lowest-scoring cluster, particularly among early career researchers, reflecting a gap between the acknowledged importance of resilience and the structured opportunities available to develop it. Many participants reported feeling unprepared for key skills—especially conflict resolution and resource optimisation—which are often acquired informally and late in a career, increasing the risk of burnout and attrition.

**Box 4. Thematic analysis linked to Factor-4 Societal Impact Methodologies.**

| Theme | Most Representative Quote | Stakeholder |
|---|---|---|
| Mixed-Methods and Methodological Breadth | "Research training has supported my development of ethical and innovative research by introducing the multiple methods by which research can be participant-led with rich, multisensory, mixed-methods approaches." | Research Student (DS19) |
| Equity, Inclusion, and Sustainability Focus | "If I could change one thing about doctoral education, it would be to embed inclusion and sustainability into the structure of research design—not as optional themes, but as core values. A successful doctorate today should not only advance knowledge but make that knowledge usable, accessible, and accountable to wider society." | Research Student (DS1) |
| Cross-Disciplinary Collaboration | "Skills: create research outputs (e.g. workflows, datasets); communicate (e.g. writing tutorials and articles); collaborate (working with biologists and computer scientists) … I occasionally use AI-based bioinformatics tools to explore datasets." | Research Student (DS13) |
| Real-World Impact and Societal Benefits | "It's frustrating sometimes, because I believe our research has so much potential to inform policy or support communities, but the academic system doesn't always encourage or reward that kind of engagement. The skills I've found most essential aren't just academic ones… being able to adapt, work ethically, and connect with people across disciplines feels more important than ever." | Research Student (DS5) |
| Overcoming Disciplinary Silos | "I think the silo of disciplines contributes to this, particularly in AI, which has an enormous engineering focus. I think it's a barrier for social innovation required to address societal challenges and global needs." | Senior Researcher (SR4) |
| Literature Synthesis and Knowledge Integration | "Yes, I use AI tools primarily for literature reviews and marketing research. For example, I used Scite.ai and Connected Papers to map the evidence base around green entrepreneurship education, and tools like ChatGPT for drafting survey instruments and analyzing open responses." | Research Associate (R1) |
| Environmental and Social Impact | "Universities can better support career development by embedding practical training, creating stronger networks with industry and NGOs, and recognising non-traditional pathways as valid. PhD research can have tremendous societal impact when aligned with urgent challenges like climate change and youth unemployment." | Research Associate (R1) |
| Interdisciplinary Team Experiences | "Having the opportunities to work collaboratively with other doctoral students and higher education colleagues throughout my doctoral studies was key in developing transferable skills such as teamwork, leadership and time management." | Research Fellow (R4) |

Thematic analysis (Box 5) revealed that resilience manifests differently across career stages. Students and early-career researchers often rely on self-motivation and informal networks to navigate stress, isolation, and limited resources, describing their doctoral journey as largely self-directed. Mid-career researchers emphasised mentorship as critical to sustaining growth and meeting evolving demands, while senior academics underscored the need for adaptability in a changing higher education landscape, yet noted persistent gaps in formal training provision.

Across stakeholders, common threads include the mental strain caused by compressed timeframes, the challenge of maintaining wellbeing under competing pressures, and the need for stronger institutional systems to sustain long-term performance. Participants described resilience as being built not only through personal drive and adaptability, but also through access to supportive supervisors, peer communities, and ongoing professional development. They also linked resilience to the cultivation of a healthy research culture—one that reduces panic during setbacks, normalises help-seeking, and values collaboration alongside individual achievement.

Convergence between the quantitative and qualitative strands for this factor was strong but took an unexpected form. Factor 5 was the lowest-scoring cluster quantitatively — with early-career researchers in particular rating these competencies as less relevant to their current roles — yet it generated the most emotionally charged qualitative content in the dataset. Box 5 contains the only themes in this study explicitly addressing mental health, burnout risk, time pressure, and isolation, with doctoral students describing their experience as 'predominantly self-driven' and expressing acute awareness of the absence of formal resilience support.

This quantitative-qualitative divergence is one of the study's most substantive integration findings: researchers may systematically underrate resilience competencies on a relevance scale precisely because they experience them as personal struggles rather than recognised professional skills, effectively masking a structural provision gap that quantitative self-assessment alone cannot surface. Phase-2 should test whether reframing resilience items as institutional conditions rather than individual capabilities yields more differentiated responses across institutional context.

**Box 5. Thematic analysis linked to Factor-5 Resilient Capacity Development.**

| Theme | Most Representative Quote | Stakeholder |
|---|---|---|
| Managing Stress and Self-Doubt | "One important point we haven't discussed is mental health and well-being. Many students face stress, isolation, or uncertainty during their PhD, especially in distance or part-time models. Institutions should prioritise well-being support, foster peer communities, and normalise help-seeking as part of healthy research culture." | Research Student (DS2) |
| Time Management and Resource Optimization | "Time constraints of a 3-year funded phd means we have limited options in terms fitting every together; that is ensuring we complete in time puts a mental strain on us and our focus is usually also limited to finishing up the thesis." | Research Student (DS4) |
| Conflict Resolution and Problem-Solving | "Personal drive and perseverance are most important because without this overcoming endless barriers is impossible... Only based on my own experience, academia is often very far removed from the real-world so impact can be a worthy aspiration but requires real-world experience to achieve." | Research Student (DS8) |
| Self-Motivation and Self-Direction | "My research training has been a variable experience, predominantly self-driven which has made it challenging on occasion to know which path to follow or what to prioritise. Focusing on areas I have some knowledge of, and expanding on these has been most impactful." | Research Student (DS8) |
| Mentorship and Peer Support | "I was fortunate to have supervisors who truly believed in my potential and consistently reminded me that I could exceed expectations through my commitment, organization, focus, and ability to communicate effectively... This kind of mentorship and inclusion in real, ongoing work developed in me a level of understanding that no formal program could have offered on its own." | Research Fellow (R8) |
| Adaptability Under Uncertainty | "A successful researcher needs to be flexible, resilient and open-minded... Researchers have the skills; however, we are constrained by the current UK HE environment, which is downwardly focused, contracting and in real trouble." | Leadership (L5) |
| Sustaining Long-Term Performance | "More ongoing support rather than little nibbles of short things. I wish I could still access vitae for example... One that can make a living and make a difference... I wish I felt more able to get a research job as this is proving hard." | Research Associate (R2) |
| Building Supportive Research Culture | "Students and their supervisors are a synthesis of ideas, creativity, inspiration, positivity and sheer hard work! Generally, the more the student engages with their studies, the more the supervisor can help and support the student... Supervisors can help the student to take a more long-term view and help to reduce that awful panicky feeling when things go wrong." | Leadership (L4) |

## 5. Discussion

The conceptual and methodological contribution of Phase-1 is not to generalise but to make Phase-2/3 generalisable. This conceptual and structural groundwork — an instrument with initial psychometric coherence, a calibrated competency language, and an identified set of institutional barriers — is what makes rigorous large-scale replication possible; without it, a multi-site study would lack the theoretical and measurement foundation needed to generate interpretable, comparable findings.

At the conceptual level (RQ1), our findings provide initial evidence supporting the coherence and context-specific robustness of the 8Cs model, warranting multi-site confirmation as a roadmap to enhance the eco-researcher identity. Empirically (RQ2), the five-factor structure and associated narratives reveal that researchers prioritise responsible, collaborative, and impact-oriented competencies but encounter uneven institutional support—particularly around resilience (Factor 5) and policy-engaged research (Factor 1).

These Phase-1 findings are consistent with a shift from competency-as-performance to competency-as-worldview a framing that warrants confirmation through multi-site replication, enabling individuals' and institutions' awareness as key fundamental factors for positioning ethics, sustainability, and justice as core research competencies rather than supplementary values (Fischer & Wiek, 2022; Mezirow, 1997; Roy *et al*., 2025). This framing invites reconsideration of traditional frameworks that treat responsibility as individual choice (Lee *et al*., 2022; Eraut, 1994) rather than structural professional requirement (Owen *et al*., 2022; Boni & Gasper, 2012).

### 5.1 Integration of theoretical and empirical framework

The 8Cs model provides a conceptual map for reflection, curriculum design, and assessment, while the five Phase-1 factors offer a complementary lens for understanding how competencies cluster in practice:

1. **Responsible Policy-Engaged Research** ensuring ethical approaches, risk management, and community empowerment. This factor maps to the eco-outwards framework through the researcher's commitment to responsible innovation (Stilgoe *et al*., 2013; Owen *et al*., 2022) and anticipatory governance (Dedeurwaerdere, 2024). Phase-2 validation should examine whether high scores correlate with observed engagement in responsible-research practices.

2. **Collaborative Inclusive Leadership** fostering diversity, inclusion, and synthesis of diverse perspectives. Grounded in epistemic justice and pluralism (Walker & Boni, 2006; Owens & Brant, 2023), this factor reflects how eco-researchers engage with marginalised voices and challenge deficit models of expertise.

3. **Interdisciplinary Networked Innovation** enabling cross-sector networking, innovation, and eco-social impact. This connects to systems thinking (Wiek *et al*., 2011; Horcea-Milcu *et al*., 2024) and transdisciplinary collaboration (Dedeurwaerdere, 2024) essential for addressing interconnected global challenges.

4. **Societal Impact Methodologies** promoting open, equitable research and evaluation of impact for a sustainable future. Aligned with RRI principles (Stilgoe *et al*., 2013) and the new UNESCO emphasis on research-education integration for the SDGs (UNESCO, 2024).

5. **Resilient Capacity Development** supporting conflict resolution, adaptability, and resource management for sustained contributions in dynamic contexts.

These five factors—responsible research, collaborative leadership, interdisciplinary networking, methodological breadth, and resilience—together constitute a coherent architecture for the eco-researcher role by integrating the CARE–KNOW–DO principles: commitment (CARE) to sustainability and justice, systems-level understanding (KNOW), and capacity to catalyse change (DO). The dual structure captures both comprehensive competency coverage (8Cs) and integrated, priority competency clusters (five factors), enabling targeted professional development while keeping eco-outwards commitments inseparable from practice.

The 8Cs offer scaffolding for comprehensive curriculum design and reflective development, whereas the factors highlight priority areas for intervention. Critically, all five factors embody the eco-outwards orientation in that none separates technical skill from ethical purpose (Cole *et al*., 2023; McAlpine & Amundsen, 2018). Together, these constructs form an empirically grounded, career-spanning model for strengthening individual and systemic research capacity, offering a transferable framework for policy, training, and institutional strategy.

Figure 5 illustrates how eco-researcher identity develops progressively across three roles, with each 8Cs competency becoming more outward-facing, systemic, and regenerative in its mode of enactment — from individual disciplinary practice toward ecosystemic, policy-embedded action. Each competency is paired with its associated capability factor (F1–F5); for example, the COLLABORATE domain shifts from *across fields* (Connected Researcher), to *trust-based* (Project Coordinator), to *diplomatically* (Network Leader).

Conceptually and empirically, this figure provides a synthetic visual of the eco-outwards competence architecture across roles, linking competency-as-worldview to the 8Cs, CARE–KNOW–DO principles, and multiple roles enacted by individuals, teams and networks.

#### *5.1.1 Theoretical implications for regenerative research*

This is not a weakness of the instrument but a substantive finding: it suggests that researchers experience societal impact as simultaneously a methodological commitment and an ethical-policy responsibility, cutting across both factors rather than residing neatly in one. This cross-factor permeability is consistent with the CARE–KNOW–DO model, in which doing (methodology) and caring (ethical responsibility) are conceived as inseparable, and warrants examination in Phase-2 through confirmatory factor analysis of whether a bifactor or hierarchical structure better represents this overlap.

### 5.2 Key empirical insights

In this Phase-1 analysis, all five factors are widely valued by researchers, yet aspiration–practice gaps arise predominantly from institutional barriers (funding constraints, time poverty, siloed promotion, weak cross-sector partnerships)—not individual deficits (Boxes 1–5). These aspiration–practice gaps map onto the three eco-outwards roles in Figure 5, where institutional conditions shape how far researchers can move from connected practice to project and network leadership. This robustness emerges from Design-Based Research (DBR) capturing researchers as societal actors (citizens/professionals/future eco-outwards researchers), whose lived experiences illuminate development trajectories. Three key patterns emerged:

Resilience is not purely individual: Participants articulated how personal resilience is strengthened by institutional support-mentoring relationships, wellbeing initiatives, and formal conflict-resolution structures. Their narratives suggest these systemic supports enable individual capacity-building rather than placing the burden solely on the individual.

Policy engagement is structured, not spontaneous: Researchers described policy-engaged work as requiring deliberate institutional conditions: co-creation relationships with stakeholders, sustained partnership frameworks, and formal

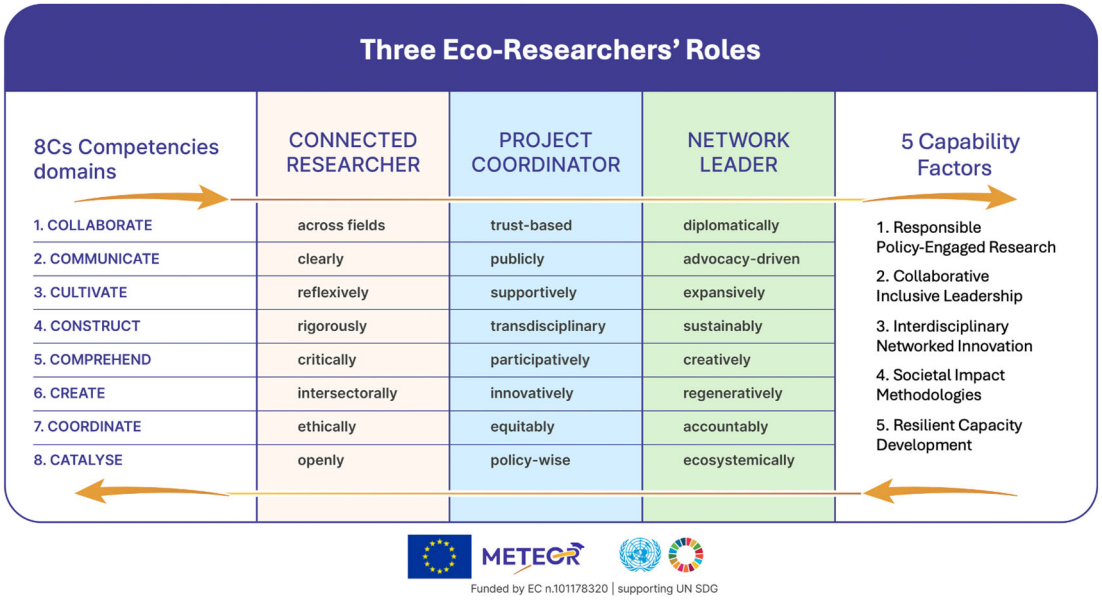



**Figure 5. The 8Cs competency model mapped across three progressive eco-researcher roles — Connected Researcher, Project Coordinator, and Network Leader.** Source: Okada, 2025a.

recognition mechanisms within evaluation systems. Without these structures, policy engagement remains episodic rather than systematic.

Interdisciplinary collaboration requires systemic conditions: Participants identified three concrete enablers: dedicated time allocated to cross-faculty work, adequate resources for collaborative projects, and organizational cultures that legitimize interdisciplinary practice. In their absence, researchers revert to disciplinary silos despite strong motivation to collaborate.

Individual motivation alone is insufficient: This underscores that eco-outwards researchers need coordinated institutional, policy, and sectoral support to thrive (Renick *et al*., 2024; Martínez & Tejero, 2025).

We conceptualise the eco-researcher identity drawing together three interrelated strands. First, beyond technical expertise, it foregrounds ethical–ecological responsibility, treating research as accountable to planetary boundaries and social justice rather than to narrow performance metrics. Second, it cultivates place-based and more-than-human awareness, recognising that knowledge is situated in specific communities, ecosystems and histories, and that research must respect human and non-human interdependence. Third, it embraces transdisciplinary engagement, working across disciplines and sectors with communities, policymakers and practitioners to co-define problems and co-produce solutions.

It embeds futures and systems thinking, linking present decisions to intergenerational impacts through anticipatory governance and futures literacy. Eco-researchers adopt an action-orientation beyond the academy, seeing publication as one step within wider cycles of collaboration, advocacy and institutional change. Finally, this orientation is grounded in regenerative lifelong learning, in which continual reflection, equity-oriented development and resilience are cultivated to restore and transform socio-ecological systems rather than merely minimise harm.

This study illuminates what eco-outwards research looks like in practice. An institutional response rate of less than 2%, contrasted with 300% growth driven by peer activation, is consistent with an aspiration-practice gap. Although the low response rate constrains population-level generalisation, three converging features lend analytical weight to the findings. Within narrative inquiry, a self-selected sample of practitioners already engaged with the phenomenon under study is often *more* epistemically valuable than a large random sample, precisely because participants can articulate tensions, barriers, and aspirations from inside lived experience. The persistent non-response despite repeated institutional reminders is itself a naturalistic signal about structural conditions surrounding researcher engagement — not merely a methodological inconvenience. Finally, the internal consistency between participants' reported aspirations, perceived barriers, and observable practice patterns suggests these are genuine, ecologically valid responses rather than artefacts of instrument design or researcher expectation. Together, these three features justify treating the findings as analytically meaningful within their declared methodological frame, even while acknowledging the limits of their generalisability.

The study proposes five defining features of the eco-outwards researcher, framing this identity as a competency-as-worldview that must be enacted, not merely held:

- Ethical-ecological responsibility
- Place-based and more-than-human awareness
- Transdisciplinary engagement
- Futures and systems thinking
- Action-orientation beyond the academy

A synthesis of these strands-Eco-researchers' Capability Domains, Defining Features, and Emerging Trends-presented in Table 9, integrates EFA, CARE–KNOW–DO, and professional identity development in a way that extends beyond the empirical findings. This synthesis constitutes the paper's primary theoretical contribution: a five-feature model of the eco-researcher grounded in empirical evidence.

This interpretation is consistent with the paper's central argument that aspiration-practice gaps are institutional rather than individual in origin — here, even the measurement instrument risks reproducing the individualisation of resilience that the paper critiques.

These features are sustained through regenerative lifelong learning, a cross-cutting orientation that shapes the eco-researcher over time and connects individual reflection to systemic, intergenerational responsibility. They are analytically derived from engagement with five practice-oriented capability domains, which provide a practical language for reflection and development.

### 5.3 Policy and framework alignment

The sustainability and scaling of eco-outwards researcher development depend on coordinated alignment across funders, policymakers, employers, and professional networks. Despite strong international commitments, including the Sustainable Development Goals and Horizon Europe, structural barriers persist, such as short-term contracts, narrow evaluation metrics, and limited investment in researcher development.

Phase-1 identifies three leverage points for systemic change: funding and evaluation structures; recruitment and progression systems; and professional networks — each addressed in §5.4.

The upSKILL.map framework aligns with major international and national policy agendas, including the Sustainable Development Goals (SDGs 4, 10, and 17), Horizon Europe Strategic Plan 2025–2027, Responsible Research and Innovation (RRI), and the Global Sustainable Development Report (2023). These frameworks emphasise interdisciplinarity, societal engagement, and the integration of sustainability competencies across sectors. upSKILL.map complements the Vitae Researcher Development Framework by explicitly foregrounding ethics, justice, sustainability, and societal responsibility, supporting the advancement of researcher identity towards more inclusive, future-oriented roles.

In Phase-1, upSKILL.map functioned as a diagnostic and reflective instrument rather than an intervention, enabling researchers to articulate their developmental needs and eco-outwards perspectives. Within a self-selected institutional cohort, participants revealed shared commitments to sustainability and societal engagement, indicating the emergence of an eco-outwards research community. These findings highlight the potential of competency-based frameworks to support systemic transformation when embedded within aligned institutional and policy environments.

**Table 9. Eco-Researchers from Identity to Practice.**

| Eco-Outwards Defining Features (Emerging Trend) | Enabling Capability Domain | Enactment in Research Practice |
|---|---|---|
| Ethical–ecological responsibility (**Regenerative Education**) | Responsible, policy-engaged research | Integrates ethical reasoning, reflexivity, and engagement with policy and public stakeholders to anticipate and address research impacts |
| Place-based and more-than-human awareness (**Place-Based & Plural Epistemic Education**) | Collaborative, inclusive leadership | Cultivates attentive, co-creative relationships with diverse stakeholders, including global majority and less represented groups, and local environments, fostering recognition of multiple ways of knowing |
| Transdisciplinary engagement (**Inter- & Transdisciplinary Innovation Learning**) | Interdisciplinary networking for innovation | Enables cross-sector and cross-discipline collaboration to co-design solutions for complex societal challenges, drawing on diverse knowledge systems and practitioner expertise beyond academia |
| Futures and systems thinking (**Futures Literacy & Human-Planet Led AI to enhance Systems Thinking**) | Methodologies for social impact | Uses participatory, mixed, and creative approaches to understand systemic interconnections, anticipate long-term consequences, and leverage AI-informed insights |
| Action-orientation beyond the academy (**Action Research & Societal Impact Learning**) | Resilient capacity development | Strengthens emotional resilience, adaptability, and supportive cultures, enabling sustained action and practical knowledge translation |

### 5.4 Phase-2 Research agenda: From diagnosis to systemic transformation

Importantly, this agenda explicitly reframes societal engagement not as a dissemination activity at the end of research, but as a practice-embedded, participatory process spanning research design, training, partnerships, and career development across sectors. Building on Phase-1 diagnostic insights, Phase-2 research advances three substantive questions that position this work within emerging fields:

**Curriculum and developmental pathways:** Multi-institutional studies should test whether embedding eco-outwards competencies in early researcher training, using CARE–KNOW–DO principles, correlates with sustained engagement in responsible and collaborative research across career stages—including non-academic pathways in government, industry, NGOs, and civil society.

**Competency evolution and career outcomes:** Phase-3 will extend Phase-1 and Phase-2 findings through longitudinal, multi-institutional research (target: 10+ institutions, n = 300–500 researchers tracked over 3+ years). This larger scale enables Confirmatory Factor Analysis (CFA) and concurrent mixed-methods inquiry to examine: (1) How do researchers' five-factor eco-outwards profiles evolve over time? (2) How do these trajectories relate to career destinations within and beyond academia? (3) How does upSKILL.map use correlate with measurable increases in collaborative, responsible, and regenerative research practices? (4) How do institutional barriers and enablers (identified in Phase-1) constrain or facilitate eco-outwards competency development at different scales?

**Systemic enablement:** Phase-2 research should examine how aligning institutional promotion criteria, mentoring systems, and cross-sector partnerships with five-factor competencies affects research culture and researcher orientation. Evidence from early adopters—institutions embedding the framework into the Researcher Development Concordat—could illuminate barriers and enablers for scaling eco-researcher communities.

Together, these investigations position upSKILL.map not only as a reflective diagnostic tool but as a mechanism for systemic transformation, advancing doctoral education's contribution to global sustainability and equity agendas. The following questions situate this research within wider emerging fields and debates, advancing how doctoral education and researcher development respond to polycrisis-era agendas across institutional, national, and international levels:

Futures literacy and anticipatory competence: Can upSKILL.map be integrated into futures literacy curricula to strengthen researchers' capacity for systems thinking, temporal responsibility, and engagement with long-term sustainability scenarios? This will be examined in Phase-2 through embedded curriculum pilots at two external METEOR academies, with longitudinal tracking to assess competency change over time. Factor 3's clustering of adaptive thinking, cross-disciplinary synthesis, and network-building offers the Phase-1 entry point for this enquiry.

### 5.5 Institutional pathways for transformation

The upSKILL.map instrument operationalises the 8Cs competency model across three interconnected levels: individual development (micro), programme and institutional structures (meso), and alignment with national and global frameworks (macro). This multi-level applicability enables sustainability, equity, and societal responsibility to be embedded as core components of researcher development rather than supplementary enhancements.

The five-factor structure provides a practical foundation for assessing researcher development needs, informing curriculum design, strengthening supervision practices, and aligning institutional strategy with global research and policy priorities, pending Phase-2 confirmation. This structured approach supports the eco-researcher and contributes to strengthening research capacity and global knowledge exchange.

Institutional transformation requires coordinated action across multiple stakeholder groups, including programme leaders, institutional leadership, funders, employers, and professional associations (Table 10). Embedding eco-outwards competencies across curriculum, mentoring, recruitment, evaluation, and partnership systems enables interdisciplinary collaboration, inclusive leadership, and policy-engaged research.

These insights highlight the urgent need for strategies to bridge the gap between aspiration and practice by embedding policy and community engagement across all phases of research. Prioritising opportunities for students and early-career researchers to engage in real-world issues from the outset—through co-design, sustained collaboration, and iterative negotiation of research use—can help build the skills captured in Factor 1. Equally, institutional reform, including addressing funding limitations and rigid structures, is essential to cocreate an enabling environment where responsible, impactful research is systematically supported.

**Table 10. Fostering Eco-Outwards Identity Across Stakeholders (Multi-level Actions & Outcomes).**

| Stakeholder Group | Key Actions | Expected Outcomes |
|---|---|---|
| Programme Leaders & Curriculum Designers | Embed 8Cs model and CARE–KNOW–DO principles; integrate eco-outwards competencies into training and assessment | Researchers develop systems thinking, ethical responsibility, collaboration, public engagement |
| Research Project Coordinators | Foster peer mentoring, collaborative projects; use upSKILL.map to identify needs; recognize team outputs | Inclusive communication, epistemic justice, shared leadership |
| Research Network Leaders | Establish structured partnerships with government, NGOs, civil society; allocate resources for policy-informed activities | Stronger researcher capacity, sustained policy engagement |
| Organizational Heads & Directors | Promote cross-faculty groups, mentorship, inclusive cultures; revise promotion pathways | Interdisciplinary collaboration, well-being support, recognition of eco-outwards leadership |
| Funders & Policymakers | Prioritize researcher development funding; integrate five-factor assessment; support cross-institutional networks | Enable long-term, policy-engaged research |
| Employers & Industry | Align recruitment/evaluation with eco-outwards competencies; provide mentoring & cross-sector development | Strengthen transferable skills and leadership |
| Professional Associations & Networks | Explore five-factor framework; foster communities of practice; reward societal impact | Cultivate collaborative, sustainable, and policy-oriented research culture |

Overall, Factor 5 emerges as a cross-cutting capability that underpins the capacity to persist, adapt, and grow amidst adversity. Strengthening resilience requires moving beyond reliance on individual coping strategies to embed institutional supports—mentorship schemes, conflict resolution training, wellbeing initiatives, and career development pathways—that enable researchers to thrive and contribute to a sustainable, inclusive research environment.

#### *5.5.1 Enacting Eco-Outwards Orientation in Practice*

Evidence from the METEOR-UK initiative at The Open University suggests the practical feasibility of embedding eco-outwards competencies within diverse institutional contexts. The Phase-1 five-factor clustering has informed redesigned induction pathways, including academy, incubator, and accelerator opportunities. In particular, Responsible policy-engaged research and Collaborative inclusive leadership support structured induction and mentoring activities; Interdisciplinary networked innovation informs cross-faculty review and collaboration processes; and Resilient capacity development underpins supervisor development initiatives, positioning supervisors as mentors supporting eco-outwards researchers.

Within the Faculty of Science, Technology, Engineering and Mathematics (STEM), the framework aligns with researcher career development priorities, including early-career researcher support structures (Mostéfaoui & Gardner, 2021). Its application strengthens programme innovation by supporting the advancement of transferable competencies relevant across academic, industry, educational, and international research contexts (Open University, 2024a, 2025).

Within the Faculty of Wellbeing, Education and Language Studies (WELS), the framework supports strategic priorities focused on inclusive research cultures, meaningful career development pathways, and continuous institutional improvement (Open University, 2018, 2024a, 2024b). It contributes to values-led researcher development and strengthens institutional capacity to respond to evolving societal, educational, and sustainability challenges. Complementary institutional initiatives, such as the Open Societal Challenges programme, further support postgraduate researchers in contributing to impact-oriented projects addressing sustainability, wellbeing, and social inequalities (Open University, 2023; Dana *et al.*, 2021).

Together, these institutional applications indicate how curriculum integration, structural alignment, stakeholder coordination, and career development pathways can operationalise eco-outwards researcher identity. Embedding justice, equity, and sustainability as core components of researcher development supports evidence-informed institutional transformation and strengthens the capacity of research systems to address complex global challenges (Cole *et al.*,

2023; McAlpine & Amundsen, 2018). The aspiration–practice gaps documented across all five factors — and the institutional conditions participants identified as barriers — provide the evidential basis for four practice-oriented recommendations.

***R1. Curriculum and assessment integration***

Phase-1 findings suggest that embedding the 8Cs model and five-factor structure within doctoral curriculum design, supervision, and programme evaluation strengthens structured competency development. The upSKILL.map instrument supports this by identifying competency gaps, enabling tailored capacity-building, and informing annual review processes aligned with societal engagement and sustainability priorities.

***R2. Structural and cultural transformation***

Phase-1 evidence suggests that promotion and reward systems that recognise collaborative contributions, inclusive leadership, and policy-engaged research are associated with stronger eco-outwards competency development. Institutional cultures that support eco-outwards research mentoring, interdisciplinary collaboration, and equitable participation enable the advancement of eco-researcher identities (Martínez & Tejero, 2025; Renick *et al*., 2024; Lawrence *et al*., 2024; Horcea-Milcu *et al*., 2024).

***R3. Stakeholder alignment and coordinated investment***

Phase-1 findings point to coordinated engagement across stakeholder groups, including programme leaders, institutional leadership, funders, employers, and professional networks as a priority condition for sustainable transformation. Strengthening institutional support for mentoring, researcher development, and cross-sector collaboration appears to be an important enabler of sustained societal engagement and advancing eco-outwards research practice.

***R4. Career pathway diversification and employability***

Phase-1 competency profiles suggest doctoral education is strengthened when it prepares researchers for diverse career pathways across academia, policy, industry, and civil society. Developing transferable competencies—including systems thinking, collaborative leadership, and stakeholder engagement—enhances employability and supports sustainable and responsible innovation (European Commission, 2023).

## 6. Conclusion

The claims below are theoretical syntheses informed by Phase-1 evidence; empirical generalisations await Phase-2 confirmation.

This study argues that sustainability, equity, and justice can be treated as integral to the eco-researcher, shaping professional practice rather than serving as supplementary considerations. Researchers' engagement with SDG-aligned impact mechanisms and qualitative narratives illustrates that these principles function as foundational commitments guiding ethical, socially responsive, and regenerative research. The five preliminary capability factors—Responsible policy-engaged research, Collaborative inclusive leadership, Interdisciplinary networked innovation, Societal Impact Methodologies, and Resilient Capacity Development—capture the coherent structure of eco-outwards competencies, highlighting the interconnected nature of research capabilities that extend beyond technical expertise. Qualitative evidence further reveals an aspiration–practice gap, in which researchers value these commitments but encounter institutional and systemic barriers, positioning the eco-outwards research framework as a conceptually and empirically grounded orientation with real-world implications.

While the eco-researcher emerged from a self-selected cohort, it represents one legitimate professional orientation among diverse research pathways, including fundamental, applied, and curiosity-driven inquiry. By demonstrating that competency functions as a worldview, this study challenges conventional frameworks that treat ethics, sustainability, and societal engagement as optional extensions of technical skill (Owen *et al*., 2022; Cole *et al*., 2023). This perspective addresses longstanding critiques of linear knowledge translation and the 'valley of death' between discovery and implementation (Lenfant, 2003; Butler, 2008; Greenhalgh & Wieringa, 2011), as well as narrow, thesis-focused doctoral apprenticeship models that often leave graduates underprepared for interdisciplinary, policy-engaged, and societal roles (Spronken-Smith, 2018). The eco-researcher emerges as a professional orientation capable of navigating polycrises in regenerative education, green economies, nature-based solutions, and equitable digital transformation, while remaining aligned with broader academic and disciplinary goals.

The upSKILL.map instrument operationalizes this framework as a bridge between individual capability development and systemic transformation. Beyond technical skill acquisition, it supports problem definition, co-production of knowledge, and evaluation of societal and sustainability impacts. By surfacing gaps across competency domains, upSKILL.map allows training centers, academic leaders, and mentors to redesign pathways that cultivate eco-outwards capabilities and close research–practice gaps (Taylor & Archer, 2022). Its structured mechanisms, including portfolios/digital badges (Abdelghaffar & Eid, 2025), provide transparent, transferable evidence for career progression, formative feedback, and institutional benchmarking.

This study contributes to global efforts to reposition sustainability, equity, and justice as core dimensions of researcher development (Cole *et al*., 2023; Lähteenmäki-Uutela *et al*., 2024), in alignment with the United Nations Sustainable Development Goals (United Nations, 2023), Horizon Europe's Responsible Research and Innovation agenda (European Commission, 2023, 2025a, 2025b), and emerging models of transformative and regenerative research systems (Horcea-Milcu *et al*., 2024; Dedeurwaerdere, 2024). The eco-researcher identity exemplifies orientations already embodied by scholars in polycrisis contexts. This orientation aligns with higher education imperatives to cultivate ethical imagination, civic responsibility, and collaborative problem-solving capacities necessary for addressing complex global challenges (Reimers, 2020; UNESCO, 2020). It further reflects regenerative learning paradigms that restore socio-ecological systems, foster integrative and ethical forms of intelligence, and enable understanding-oriented knowledge transfer across real-world contexts (Sterling, 2021; van den Berg & Wals, 2022; Gardner, 2011; Perkins, 2010). Phase-2 and Phase-3 will extend this work through multi-institutional replication, longitudinal tracking, and confirmatory factor analysis to test generalisability beyond the present cohort.

By articulating and preliminarily characterising eco-outwards capabilities within a self-selected Open University cohort, this study offers an analytically transferable framework that, with multi-institutional adaptation, can inform research culture across higher education. The eco-outwards research framework, enacted through the upSKILL.map instrument, links individual development to systemic transformation. In doing so, the study advances a shift from competency as individual performance toward capability as a worldview — fostering relational, responsible, and future-oriented research practices that align research systems with planetary stewardship and the common good.

## Ethics declarations

The study was conducted in accordance with the Declaration of Helsinki and approved by The Open University Human Research Ethics Committee (HREC 2025–0889-4).

## Informed consent statement

Informed consent was obtained from all participants involved in the study (written form).

## AI use disclosure

This study selectively employed AI technologies to support research and writing. **Perplexity** assisted with APA formatting and language consistency, while **ChatGPT** helped condense the abstract to 300 words. A UML diagram was generated using an AI image tool, and **Springer AJE ProofReader** provided additional language editing. **NVivo** and **ATLAS AI** supported verification of thematic analyses. Quantitative analyses were conducted using **SPSS** and **R**, with **Claude** providing coding assistance. All results were carefully reviewed to ensure accuracy and integrity. The full manuscript underwent review by four internal team members and two external partners.

## Data availability

The data are available via **Open Research Data Online (ORDO)** at The Open University. All datasets were prepared according to the project's data management plan and reviewed by the Open Research Library Team. The database captures responses from 40 researchers who participated in the **upSKILL** study.

- **Project Repository:** METEOR Open Repository Online Data. The Open University.

  https://ordo.open.ac.uk/projects/METEOR/244817

- **Dataset:** upSKILL.map Phase-1 dataset. The Open University.

  https://doi.org/10.21954/ou.rd.30108928

- **Instrument:** upSKILL.map self-reported instrument [Questionnaire]. The Open University.

https://doi.org/10.21954/ou.rd.30109057

- **Qualitative Analysis:** Thematic Codebook.

  https://doi.org/10.21954/ou.rd.31557559

- **Quantitative Analysis:** Appendix 1 – upSKILL.map data.

  https://doi.org/10.21954/ou.rd.31558528

- **Video Abstract:** Overview of the eco-outwards research framework, upSKILL.map.

  https://www.youtube.com/watch?v=Cl91GhlrHmU

All materials are available under a Creative Commons Attribution–ShareAlike (CC BY-SA) licence. Data transparency commitments have been balanced against participant protection obligations within the bounds of participants' informed consent, particularly given the identifiability risk inherent in a small sample with intersecting demographic characteristics — a tension increasingly recognised in open science guidance for qualitative and mixed-methods research (Weller, 2023; Barnes & Weller, 2017; Van den Eynden *et al*., 2011).

In keeping with the participatory ethics underpinning this study, participants were offered collective attribution in published outputs including the think piece and video clip — recognising their role as co-producers of knowledge and enacting the data sovereignty commitments that governed all data collection, sharing, and retention decisions in this study.

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## References

Abdelghaffar A, Eid L: **A critical look at equity in international doctoral education at a distance: a duo's journey.** *Br J Educ Technol.* 2025; **56**(2): 834–851.
**Publisher Full Text**

Anderson T, Shattuck J: **Design-based research: A decade of progress in education research.** *Educ Res.* 2012; **41**(1): 16–25.
**Publisher Full Text**

Baker DP, Powell JJW: *Global mega-science: Universities, research collaborations, and knowledge production.* Stanford, CA: Stanford University Press; 2024.
**Publisher Full Text**

Barnes J, Weller N: **Case studies and analytic transparency in causal-oriented mixed-methods research.** *PS Polit Sci Polit.* 2017; **50**(4): 1019–1022.
**Publisher Full Text**

Bianchi G, Pisiotis U, Cabrera Giraldez M: **GreenComp The European sustainability competence framework.** *Eur.* 2022: **30955**: 1–40.

Boateng GO, Neilands TB, Frongillo EA, *et al.*: **Best practices for developing and validating scales for health, social, and behavioral research: a primer.** *Front Public Health.* 2018; **6**: 149.
**PubMed Abstract** | **Publisher Full Text** | **Free Full Text**

Boni A, Gasper D: **Rethinking the quality of universities: How can human development thinking contribute?** *J Hum Dev Capab.* 2012; **13**(3): 451–470.
**Publisher Full Text**

Braun V, Clarke V: **Reflecting on reflexive thematic analysis.** *Qual Res Sport Exerc Health.* 2019; **11**(4): 589–597.
**Publisher Full Text**

Brown A, Smith L, Patel R: **HIRES-PhD: a researcher skill framework.** *J High Educ.* 2024; **95**(2): 123–145.

Butler D: **Translational research: crossing the valley of death.** 2008.
**Reference Source**

Cattell RB: **The scree test for the number of factors.** *Multivar Behav Res.* 1966; **1**(2): 245–276.
**Publisher Full Text**

Chankseliani M: **The long horizon: why international education matters for poverty reduction.** *J Comp Int Educ.* 2023; **53**(8): 1209–1225.

Chen X, Cheung M, Zhou S, *et al.*: **Reflections on social work doctoral pedagogy: a reciprocal approach to enhancing preparation for the academy.** *J Teach Soc Work.* 2020; **40**(4): 385–401.
**Publisher Full Text**

Clandinin DJ, Connelly FM: *Narrative inquiry: Experience and story in qualitative research.* Jossey-Bass; 2000.

Cole NL, Reichmann S, Ross-Hellauer T: **Toward equitable open research: stakeholder co-created recommendations for research institutions, funders and researchers.** *R Soc Open Sci.* 2023; **10**(2): 221460.
**PubMed Abstract** | **Publisher Full Text** | **Free Full Text**

Costello AB, Osborne JW: **Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis.** *Pract Assess Res Eval.* 2005; **10**(7): 1–9.

Cranton P: *Understanding and promoting transformative learning: a guide for educators of adults.* 2nd ed. San Francisco, CA: Jossey-Bass; 2006.

Creswell JW, Plano Clark VL: *Designing and conducting mixed methods research.* 3rd ed. SAGE Publications; 2018.

Dalkey NC: *The Delphi method: An experimental study of group opinion (RM-5888).* RAND Corporation; 1969.

Dana NF, Rigney J, Vescio V, *et al.*: **Project-Based Learning and Doctoral Student Research Skill Development: A Case Study.** *Impacting Education: Journal on Transforming Professional Practice.* 2021; **6**(4): 27–35.
**Publisher Full Text**

Dedeurwaerdere T: *Transdisciplinary research, sustainability, and social transformation: Governance and knowledge co-production.* Taylor & Francis; 2024.
**Publisher Full Text**

Design-Based Research Collective: **Design-based research: an emerging paradigm for educational inquiry.** *Educ. Res.* 2003; **32**(1): 5–8.
**Publisher Full Text**

de Winter JCF, Dodou D, Wieringa PA: **Exploratory factor analysis with small sample sizes.** *Multivar Behav Res.* 2009; **44**(2): 147–181.

Eraut M: *Developing professional knowledge and competence.* London, UK: Falmer Press; 1994.

ESCO Green Skills and Knowledge Concepts: Labelling the ESCO classification. 2025.
**Reference Source**

ESCO: European Skills, Competences, Qualifications and Occupations (ESCO) v1.2. European Commission, Brussels, Belgium, 2025b.

European Commission: *Horizon Europe strategic plan 2025–2027.* Luxembourg: Publications Office of the European Union; 2023.
**Publisher Full Text**

European Commission: *ResearchComp: European Competence Framework for Researchers*, 2025a.
**Reference Source**

European Commission: *RM Comp, the European Competence Framework for Research Managers.* 2025b.
**Reference Source**

Fabrigar LR, Wegener DT, MacCallum RC, *et al.*: **Evaluating the use of exploratory factor analysis in psychological research.** *Psychol Methods.* 1999; **4**(3): 272–299.
**Publisher Full Text**

Fischer D, Wiek A: **Competencies for sustainability: rethinking higher education.** *J Educ Sustain Dev.* 2022; **16**(2): 101–119.

Garcia M, Lee J, Chen S: *Project-based learning for researcher development.* Elsevier; 2017.

Gardner H: *Truth, beauty, and goodness reframed: Educating for the virtues in the twenty-first century.* Basic Books; 2011.

Glorfeld LW: **An improvement on Horn's parallel analysis methodology for selecting the correct number of factors to retain.** *Educ Psychol Meas.* 1995; **55**(3): 377–393.
**Publisher Full Text**

Gorsuch RL: **Factor analysis.** 2nd ed. Hillsdale, NJ: Lawrence Erlbaum Associates; 1983.

Greenhalgh T, Wieringa S: **Is it time to drop the 'knowledge translation' metaphor? A critical literature review.** *J R Soc Med.* 2011; **104**(12): 501–509.
**PubMed Abstract** | **Publisher Full Text** | **Free Full Text**

Hattie J, Timperley H: **The power of feedback.** *Rev Educ Res.* 2007; **77**(1): 81–112.
**Publisher Full Text**

Horcea-Milcu A-I, Dorresteijn I, Leventon J, *et al.*: **Transformative research for sustainability: Characteristics, tensions, and moving forward.** *Glob Sustain.* 2024; **7**: e14.
**Publisher Full Text**

Horn JL: **A rationale and test for the number of factors in factor analysis.** *Psychometrika.* 1965; **30**(2): 179–185.
**Publisher Full Text**

Kaiser HF: **An index of factorial simplicity.** *Psychometrika.* 1974; **39**(1): 31–36.
**Publisher Full Text**

Lähteenmäki-Uutela A, Ituarte-Lima C, Turunen T, *et al.*: **Planetary boundaries nurturing the grand narrative of the right to a healthy environment?** *Environ Policy Law.* 2024; **54**(1): 15–26.
**Publisher Full Text**

Langston MW: **Opportunities of virtual learning environments: best practices in online doctoral programs.** Swartz S, Barbosa B, Crawford I, *et al.* editors. *Developments in Virtual Learning Environments and, the Global Workplace.* IGI Global Scientific Publishing; 2021: 141–160.
**Publisher Full Text**

Lawrence M, Homer-Dixon T, Janzwood S, *et al.*: **Global polycrisis: the causal mechanisms of crisis entanglement.** *Glob Sustain.* 2024; **7**: e6.

Lee S, Patel R, Brown A: **Employability and researcher competencies: a longitudinal study.** *Stud High Educ.* 2022; **47**(4): 789–806.

Lenfant C: **Shattuck Lecture—Clinical research to clinical practice—Lost in translation?** *N Engl J Med.* 2003; **349**(9): 868–874.
**Publisher Full Text**

Lincoln YS, Guba EG: *Naturalistic inquiry.* Beverly Hills, CA: Sage Publications; 1985.

Linstone HA, Turoff M, Dalkey NC, editors: *The Delphi method: Techniques and applications.* Addison-Wesley; 2002.

Martínez R, Tejero A: **Transforming research at higher education institutions: overcoming challenges for research managers in Spain.** *Cogent Bus. Manag.* 2025; **12**(1): 2470909.
**Publisher Full Text**

McAlpine L, Amundsen C: *Identity-trajectory of early career researchers: unpacking the post-PhD experience.* Cham, Switzerland: Palgrave Macmillan; 2018.
**Publisher Full Text**

Mezirow J: **Transformative learning: theory to practice.** *New Dir Adult Contin Educ.* 1997; **1997**(74): 5–12.
**Publisher Full Text**

Michel JO, Brundiers K, Barth M, *et al.*: **Sustainability competencies in higher education.** *The Palgrave Encyclopedia of Urban and Regional Futures.* Cham; Springer International Publishing; 2023; 1710–1715.

Mostéfaoui S, Gardner C: Supporting degree apprenticeship students: tutors' and students' perspectives. Open University eSTEeM Final Report. Open University, Milton Keynes, UK, 2021.

Mulder M: **Conceptions of professional competence. In International handbook of research in professional and practice-based learning.** Dordrecht: Springer Netherlands; 2014; pp. 107–137.

Nussbaum MC: *Creating capabilities: The human development approach.* Harvard University Press; 2011.
**Publisher Full Text**

Okada A, Gray P: **A climate change and sustainability education movement: Networks, open schooling, and the 'CARE–KNOW–DO' framework.** *Sustainability.* 2023; **15**(3): 2356.
**Publisher Full Text**

Okada A: Dataset upskill map. The Open University. Dataset, 2025a.
**Publisher Full Text**

Okada A: **CARE–KNOW–DO to map knowledge in education.** *Knowledge Cartography for Young Thinkers.* Cham, Switzerland: Springer; 2025b.
**Publisher Full Text**

Open University: *ESRC Grand Union Doctoral training partnership - Innovation in learning pathway.* Milton Keynes, UK: Open University; 2018.

Open University: *Inclusive innovation and development.* Milton Keynes, UK: Open University; 2024a.

Open University: *Annual report on apprenticeships and professional education.* 2024b.

Open University: *Global Education and Digital Transformation (GEDT) network.* Open University Milton Keynes, UK, 2025.

Organisation for Economic Co-operation and Development (OECD): *Global competency frameworks.* Paris, France: OECD Publishing; 2019.

Owen R, von Schomberg R, Macnaghten P: **A framework for responsible innovation: updated principles and practice.** *Res Policy.* 2022; **51**(6).

Owens T, Brant J: **From inclusion to justice: reframing equity in STEM research.** *Res Sci Educ.* 2023; **53**(4): 505–521.
**Publisher Full Text**

Patel R, Brown A, Lee S: **Curriculum design for researcher skills: lessons from international doctoral programmes.** *Int J Educ Res.* 2020; **102**: 101–115.

Perkins D: *Making learning whole: how seven principles of teaching can transform education.* San Francisco, CA: Jossey-Bass; 2010.

Piccardo C, Goto Y, Koca D, *et al.*: **Challenge-based, interdisciplinary learning for sustainability in doctoral education.** *Int J Sustain High Educ.* 2022; **23**(7): 1482–1503.
**Publisher Full Text**

Quality Assurance Agency for higher education (QAA): *Characteristics statement: doctoral degree (2nd ed.).* Gloucester, UK: QAA; 2020.

Raffaghelli JE, Manca S, Stewart B, *et al.*: **Supporting the development of critical data literacies in higher education: building blocks for fair data cultures in society.** *Int J Educ Technol High Educ.* 2020; **17**(1): 58.
**Publisher Full Text**

Reimers FM: *Educating students to improve the world: Education for deliberate citizenship.* Springer; 2020.

Reise SP, Moore TM, Haviland MG: **Bifactor models and rotations: Exploring the extent to which multidimensional data yield univocal scale scores.** *J Pers Assess.* 2010; **92**(6): 544–559.
**PubMed Abstract** | **Publisher Full Text** | **Free Full Text**

Renick J, Jentleson BW, Ozer EJ: **Supporting societally impactful research is key to enhancing universities' mission.** *SAGE Open.* 2024; **14**(2).
**Publisher Full Text**

Rodriguez A, Reise SP, Haviland MG: **Evaluating bifactor models: Calculating and interpreting statistical indices.** *Psychol Methods.* 2016; **21**(2): 137–150.
**PubMed Abstract** | **Publisher Full Text**

Roy D, Jiménez López MD, García Álvarez ME: **Hires-PhD: a transversal skills framework for diversifying PhD employability.** *Hum Soc Sci Commun.* 2025; **12**: 18.
**Publisher Full Text**

Spronken-Smith R: *Reforming doctoral education: there is a better way. Research & Occasional Paper Series: CSHE.9.18.* Berkeley, CA: Center for Studies in Higher Education, University of California, Berkeley; 2018.

Sterling S: **Concern, conception, and consequence: Re–thinking the paradigm of higher education in the Anthropocene.** *Front Sustainability.* 2021; **2**: 743806.

Stilgoe J, Owen R, Macnaghten P: **Developing a framework for responsible innovation.** *Res Policy.* 2013; **42**(9): 1568–1580.
**Publisher Full Text**

Summers JK, Smith LM, Harwell LC, *et al.*: **Conceptualizing holistic community resilience to climate events: Foundation for a climate resilience screening index.** *GeoHealth.* 2017 Jun; **1**(4): 151–164.
**Publisher Full Text**

Tabachnick BG, Fidell LS: *Using multivariate statistics.* 6th ed. Pearson; 2013.

Taylor J, Archer L: **Researcher identity and professionalisation in UK academia.** *Stud High Educ.* 2022; **47**(3): 479–495.
**Publisher Full Text**

Taylor J, Clark P: *Transversal skills in STEM roles: challenges and opportunities.* Springer; 2023.

The Open University: *The Open Societal Challenges Programme at The Open University.* 2023.
**Reference Source**

UNESCO: *Education for sustainable development goals: learning objectives.* Paris, France: UNESCO; 2017.

UNESCO: *Recommendation on science and scientific researchers.* Paris, France: UNESCO; 2018.

UNESCO: *Digital learning and transformation of education: Reimagining futures.* UNESCO Publishing; 2024.
**Reference Source**

UNESCO: *Education for Sustainable Development: A roadmap.* UNESCO; 2020.
**Publisher Full Text**

United Nations: *Global Sustainable Development Report 2023.* New York, NY: United Nations; 2023.

van den Berg B, Wals AEJ: **Practices, drivers and barriers of an emerging regenerative paradigm in higher education.** *Sustainability.* 2022; **14**(15): 9138.

Van den Eynden V, Corti L, Woollard M, *et al.*: *Managing and sharing data; a best practice guide for researchers.* UK Data Archive; 2011.

Velicer WF, Jackson DN: **Component analysis versus common factor analysis: Some further observations.** *Multivariate Behav Res.* 1990; **25**(1): 97–114.
**Publisher Full Text**

Vitae: *Vitae researcher development framework: reviewing for systemic change.* Cambridge, UK: Vitae; 2025.

von Schomberg R: **A vision of responsible research and innovation** Owen R, Heintz M, Bessant J: *Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society.* Chichester, UK: Wiley; 2013; 51–74.
**Publisher Full Text**

Walker GE, Boni A: **Fostering inclusive researcher development.** Walker GE, *et al.* editors. *The formation of scholars: rethinking doctoral education for the twenty-first century.* Jossey-Bass; 2006; 82–97.

Weller S: **Fostering habits of care: Reframing qualitative data sharing policies and practices.** *Qual Res.* 2023; **23**(4): 1022–1041.
**Publisher Full Text**

Wiek A, Withycombe L, Redman CL: **Key competencies in sustainability: a reference framework for academic program development.** *Sustain Sci.* 2011; **6**(2): 203–218.
**Publisher Full Text**

Wilson MC, Wu J: **The problems of weak sustainability and associated indicators.** *Int J Sustain Dev World Ecol.* 2017; **24**(1): 44–51.
**Publisher Full Text**

Yudkevich M, Altbach PG, De Wit H: *Trends and issues in doctoral education: a global perspective.* 2020
**Publisher Full Text**

Zimmerman BJ: **Becoming a self-regulated learner: an overview.** *Theory Pract.* 2002; **41**(2): 64–70.
**Publisher Full Text**

Zimmerman BJ, Schunk DH: *Handbook of self-regulation of learning and performance.* New York, NY: Routledge; 2011.
**Publisher Full Text**

Zwick WR, Velicer WF: **Comparison of five rules for determining the number of components to retain.** *Psychol Bull.* 1986; **99**(3): 432–442.
**Publisher Full Text**

# Open Peer Review

## Current Peer Review Status: ✔ ✔ ✔ ✔

**Version 4**

Reviewer Report 06 August 2026

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✔ **Moses Adeleke ADEOYE**
Al-Hikmah University, Ilorin, Nigeria

**Approved.**

***Competing Interests:*** No competing interests were disclosed.

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.**

Reviewer Report 20 July 2026

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✔ **Amelie E Trinidad**
Davao del Sur State College, Matti, Digos City, Davao del Sur, Philippines

I have no further comments on this revised manuscript. The authors have adequately addressed the concerns and suggestions raised in my previous review, and the revisions have improved the clarity and overall quality of the manuscript. I appreciate the authors' careful consideration of the review comments and have no additional recommendations at this stage.

***Competing Interests:*** No competing interests were disclosed.

***Reviewer Expertise:*** Educational Management; Higher Education; Doctoral Education; Teacher Education; Research Methodology (Qualitative, Quantitative, and Mixed Methods); Research

Competency Development; Faculty and Research Capacity Building; Curriculum Development; Educational Leadership; Program Evaluation; Quality Assurance and Accreditation; Artificial Intelligence in Education.

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.**

**Version 3**

Reviewer Report 11 June 2026

https://doi.org/10.21956/openreseurope.25732.r75182

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**Mona Holmqvist**
Lund University, Malmö, Skåne County, Sweden

**Manuscript Title**: Developing Researchers" Competences through CARE-KNOW-DO and upSKILL.map, aligned with EU and UNESCO Priorities
**Overall recommendations**: Approved with minor revisions

The revised version of the article has been improved, but the comments I had in my previous review have been addressed only partly. At pages 7 and 9, the authors refer to the “aspiration-practice gap”, and at p. 15, they refer to “advance participatory research principles” referring to the participants in the conducted study. However, my comments in the previous review addressed the question of “who defines the challenges” studied by the researchers. If PhD students and supervisors are supposed to advance participatory research principles, the tool should map the competencies developed for engaging members in the contexts where data are collected. The competence to develop skills that involve respondents in all phases of the research process, from design to dissemination, should be captured. The tool examines PhD students' and supervisors' self-assessed views on collaboration, focusing primarily on collaboration between researchers rather than their competences to collaborate with respondents involved in the research, which is not problematized or discussed.  Relational competences are needed for collaborative work with the respondents participating in the PhD students and their supervisors’ research. Several theoretical frameworks have contributed to the upSkill.map, however, perspectives such as improvement science and collaborative practice-oriented research are not mentioned, although they could be used to understand what competences future researchers need to conduct participatory research with high societal impact.

**Is the work clearly and accurately presented and does it engage with the current literature?**
Yes

**Is the study design appropriate and is the work technically sound?**
Yes

**Are sufficient details of methods and analysis provided to allow replication by others?**
Yes

**Are all the source data and materials underlying the results available?**
Yes

**If applicable, is the statistical analysis and its interpretation appropriate?**
I do not have the competence to review this part, however the sample of 40 participants are small.

**Are the conclusions drawn adequately supported by the results?**
Yes

**References**
1. Coburn C, Penuel W: Research–Practice Partnerships in Education. *Educational Researcher*. 2016; **45** (1): 48-54 Publisher Full Text
2. Bonney E, Yurkofsky M, Capello S: EdD Students' Sensemaking of Improvement Science as a Tool for Change in Education. *Journal of Research on Leadership Education*. 2025; **20** (1): 3-31 Publisher Full Text

***Competing Interests:*** No competing interests were disclosed.

***Reviewer Expertise:*** As a Professor of Educational Science my research focuses on the intersection of learning, teaching, inclusion, and educational improvement. A central feature of my work is the development and study of practice-based research conducted in close collaboration with teachers, schools, and educational organizations. My research is characterized by long-term partnerships with practitioners and a commitment to generating knowledge that contributes simultaneously to educational theory and the improvement of professional practice. I have conducted research on doctoral education and supervision, focusing how doctoral candidates develop as researchers, how supervisory relationships evolve during different phases of doctoral studies, and which forms of supervision are perceived as most valuable by doctoral students.

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.**

Author Response 11 Jun 2026

**Alexandra Okada**

We thank Dr Holmqvist for her continued, constructive engagement with the manuscript and are pleased that she now recommends approval, with all evaluation criteria assessed as "Yes." We respond to her two remaining points below.
**Who defines the challenges, and participatory engagement with respondents.**
This concern is taken up directly in Section 2.3 and Section 2.4. Part-1 of upSKILL.map asks participants to reflect on who contributes to the framing of research priorities, embedding

reflexivity on power and agenda-setting from the outset rather than treating challenges as pre-defined problems to be "solved."
Section 2.4 ("Embedding power and agenda-setting reflexivity") makes this explicit: participants describe how research issues are co-defined through engagement with communities, funders, policy contexts, and practitioners, and consider who influences what these issues become.
Relational and participatory engagement with the contexts in which data are generated is also represented in the competency structure — in the Construct domain (evidence-based, participatory solutions), the Catalyse domain (community empowerment, and open research for equity and inclusion, items 8.1 and 8.3), and most directly in Factor 4 (Societal Impact Methodologies), where the qualitative evidence (Box 4) foregrounds participant-led methods and working with communities and stakeholders across the research lifecycle rather than informing them only at later stages.

We agree that the measurement of relational competence — the specific capacity to involve respondents and community partners across all phases, from design to dissemination — is currently captured at the level of perceived relevance rather than as a discrete, behaviourally defined competence. As set out in Section 3.4 and Section 5.4, refining the instrument to capture this more granularly through behaviourally anchored items is a defined Phase-2 development priority. We have therefore framed this as an acknowledged direction for instrument development.

**Improvement science and collaborative practice-oriented research.**
We are grateful for these suggestions and for the Coburn and Penuel (2016) and Bonney et al. (2025) references. We agree they offer a valuable lens on the competences required for participatory, high-impact research, and that they complement the participatory and co-design commitments already grounded in the manuscript through Responsible Research and Innovation (Stilgoe et al., 2013; von Schomberg, 2013), epistemic-justice and capabilities perspectives (Walker & Boni, 2006), and narrative inquiry (Clandinin & Connelly, 2000). Research–practice partnerships and improvement science are a natural theoretical extension for the Phase-2 work, in which relational and participatory competences will be operationalised, and we will draw on this literature as that phase develops.
We thank the reviewer again for a careful and generative review.

***Competing Interests:*** No competing interests were disclosed.

**Version 2**

Reviewer Report 23 May 2026

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**Carlos Enrique GEORGE-REYES**
Bolivarian University of Ecuador, Duran, Guayas, Ecuador

**Brief description and relevance of the article**
The manuscript presents the development and Phase 1 contextual validation of upSKILL.map, a diagnostic and developmental self-assessment instrument designed to support researchers' competencies through the CARE-KNOW-DO framework. The article is aligned with EU and UNESCO priorities and seeks to move beyond traditional competency frameworks focused mainly on employability or career management by foregrounding sustainability, equity, social responsibility, and researcher identity.
The article is relevant to researcher development, doctoral education, responsible research and innovation, and sustainability-oriented higher education. Its main contribution lies in proposing a value-anchored model of researcher competencies and in offering preliminary empirical evidence for the coherence of the 8Cs framework and its five emerging capability factors. The manuscript is timely because institutions increasingly need tools to help researchers connect disciplinary expertise with societal impact, ethical responsibility, and global challenges.

**Overall assessment**
Overall, I consider this a valuable and well-motivated manuscript. The article is conceptually ambitious, clearly connected to current debates on researcher development, and useful for institutions interested in strengthening doctoral training and early-career researcher support. The manuscript is generally well structured, the research problem is clearly presented, and the combination of quantitative and qualitative evidence provides a coherent basis for the authors' argument.
The article is suitable for publication. However, I recommend minor revisions to further improve readability, methodological precision, and consistency between the scope of the evidence and the claims made in the conclusions.

**Major comments**

1. **Clarify the scope and limits of generalisability**

The manuscript appropriately acknowledges that this is a Phase 1 study based on a single institution and a modest, self-selected sample. This limitation is important and should remain visible throughout the manuscript, particularly in the abstract, discussion, and conclusion. Some statements about institutional or global applicability could be further moderated to avoid implying that the model has already been validated beyond the specific context studied. The authors may consider consistently using terms such as "preliminary evidence," "context-bound validation," or "exploratory findings" when discussing the factor structure and the potential institutional uses of upSKILL.map.

1. **Reduce conceptual density and repetition**

The theoretical framing is one of the strengths of the manuscript, especially the distinction between competency-as-performance and competency-as-worldview. Nevertheless, some sections of the introduction and conceptual framework are dense and occasionally repetitive, particularly when explaining sustainability, equity, intergenerational responsibility, and the eco-researcher

identity. I recommend streamlining selected paragraphs to improve readability while preserving the conceptual depth of the argument. This would help readers follow the progression from existing frameworks to the specific contribution of upSKILL.map more easily.

1. **Strengthen the presentation of the methodological sequence**

The use of design-based research, exploratory factor analysis, qualitative think-pieces, expert review, and user feedback is appropriate for a Phase 1 study. The manuscript provides useful methodological details, but the overall sequence could be made even clearer for readers. I suggest adding or refining a concise methodological flow that shows how the initial 32 items were developed, how four items were removed, how the final 28-item structure was analysed, and how the qualitative findings supported or refined the interpretation of the five factors. This would strengthen the transparency and replicability of the study.

1. **Maintain caution in the interpretation of the exploratory factor analysis**

The statistical analysis is generally well reported, and the authors provide justification for conducting exploratory factor analysis with a small sample. However, because the participant-to-item ratio remains limited, the factor structure should be presented explicitly as exploratory and provisional. The manuscript would benefit from a brief statement in the findings section clarifying that confirmatory factor analysis, measurement invariance testing, and larger multi-institutional samples are needed before the instrument can be used for broader validation or high-stakes decision-making.

1. **Deepen the integration between quantitative and qualitative findings**

The mixed-methods design is a valuable aspect of the study. To strengthen the integration of evidence, the authors could include a short joint display or summary table linking the five capability factors with selected qualitative themes from the think-pieces and interviews. This would help readers understand how the numerical factor structure aligns with participants' reflections on institutional support, policy engagement, collaboration, leadership, and societal impact. Such a table would also make the practical implications for doctoral schools and researcher development units more explicit.

1. **Specify practical implications for implementation**

The manuscript argues that upSKILL.map can support doctoral schools and researcher development leads in identifying gaps and designing targeted interventions. This is a promising contribution. I recommend adding more practical guidance on how the tool should be used responsibly. For example, the authors could clarify whether it is intended for formative self-reflection, programme-level diagnosis, mentoring conversations, curriculum design, or institutional planning. It would also be useful to explicitly state that the tool should not be used as an individual performance evaluation instrument at this stage.

**Minor comments**

1. Please ensure consistency in the spelling and formatting of the instrument name throughout the manuscript, for example, upSKILL.map versus upSkill.Map.
2. Some terms should be standardised across the manuscript, including "eco-outwards," "eco-researcher," "8Cs," "five capability factors," and "competency-as-worldview."
3. Several long paragraphs could be shortened to improve readability, especially in the introduction and theoretical framework.
4. Tables and figures are useful, but some visual elements could be improved for clarity and accessibility. Please ensure that all labels are readable and that each figure clearly supports the surrounding argument.
5. The manuscript would benefit from a final copy-editing pass to correct minor typographical

or formatting issues, such as spacing, punctuation, duplicated periods, and occasional inconsistencies in capitalization.

6. Please review all citations and references for consistency, especially recent framework documents and institutional sources, to ensure that every in-text citation is included in the reference list and formatted consistently.
7. The discussion could more clearly distinguish between findings directly supported by the Phase 1 data and recommendations for Phases 2 and 3.

**Final recommendation**

I recommend approval of the manuscript, subject to minor revisions. The article makes a meaningful contribution to the field of researcher development by proposing a values-based competency framework and a practical diagnostic tool aligned with sustainability, equity, and responsible research priorities. With modest revisions to improve clarity, methodological caution, and editorial consistency, the manuscript will offer a strong contribution to discussions on doctoral education, eco-social responsibility, and the future of research careers.

**Is the work clearly and accurately presented and does it engage with the current literature?**

Yes

**Is the study design appropriate and is the work technically sound?**

Yes

**Are sufficient details of methods and analysis provided to allow replication by others?**

Partly

**Are all the source data and materials underlying the results available?**

Yes

**If applicable, is the statistical analysis and its interpretation appropriate?**

Yes

**Are the conclusions drawn adequately supported by the results?**

Yes

***Competing Interests:*** No competing interests were disclosed.

***Reviewer Expertise:*** As a researcher, my work focuses on educational innovation, emerging digital literacies, artificial intelligence literacy, computational thinking, the educational impact of emerging technologies, teacher professional development, and disruptive pedagogical approaches such as Maker pedagogy. These research areas allow me to assess the manuscript from a perspective grounded in current debates on technology, education, and professional learning.

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.**

Author Response 26 May 2026

**Alexandra Okada**

Dear Carlos,
Thank you for the constructive and thoughtful feedback provided on our manuscript. We have carefully reviewed all comments and implemented the recommended revisions to strengthen the clarity, coherence, and consistency of the paper. The following changes have been addressed:

**Instrument-name consistency**
We reviewed the manuscript thoroughly and standardized the spelling and formatting of the instrument name throughout the text. All instances now consistently use the same format.

**Term standardization**
Key terms have been standardized across the manuscript to ensure conceptual consistency and readability. This includes terms such as “eco-outwards,” “eco-researcher,” “8Cs,” “five capability factors,” and “competency-as-worldview.”

**Long paragraphs**
Some lengthy paragraphs, particularly within the Introduction and Theoretical Framework sections, were revised and divided into shorter paragraphs to improve readability, structure, and flow of ideas.

**Tables and figures clarity**
Tables and figures were reviewed to improve clarity and accessibility. Labels and formatting were refined to enhance readability, and visual elements were checked to ensure each figure directly supports the surrounding discussion and argumentation.

**Final copy-editing pass**
A full copy-editing review was conducted to correct minor typographical and formatting issues, including spacing, punctuation, duplicated periods, tables' and figures' links as well inconsistencies in capitalization.

**Citations and references**
All citations and references were reviewed for consistency and completeness. Recent framework documents and institutional sources were checked carefully to ensure alignment between in-text citations and the reference list, with formatting standardized throughout.

**Phase 1 versus Phases 2 and 3 boundary in the Discussion**
The Discussion section was revised to provide a clearer distinction between findings directly supported by Phase 1 data and the forward-looking recommendations proposed for Phases 2 and 3.
We appreciate the valuable feedback, which has significantly contributed to improving the quality and clarity of the manuscript.

***Competing Interests:*** No competing interests were disclosed.

Reviewer Report 21 April 2026

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**Amelie E Trinidad**
Davao del Sur State College, Matti, Digos City, Davao del Sur, Philippines

**Review Report**

**Manuscript Title:** Developing Researchers' Competencies through CARE–KNOW–DO and upSkill.Map, aligned with EU and UNESCO Priorities
**Authors:** Okada A., Sheehy K., Dieter Rossade K., & Bandara A.K.

**Overall Recommendation: Approved with Minor Revisions**

**A. Clarity and Engagement with Literature - Yes**
The manuscript has significantly improved in terms of clarity and engagement with the literature. The introduction is now more concise and better structured, and the inclusion of a comparative table effectively clarifies how upSkill.Map advances existing competency frameworks (e.g., ResearchComp, Vitae RDF, OECD frameworks). This emphasis on structured competency development aligns with systematic evidence regarding the training of research skills in modern learning environments (Garay-Argandoña et al., 2021).. The integration of additional literature on research–practice gaps further strengthens the conceptual grounding of the study.
However, some sections remain conceptually dense, with minor repetition in emphasizing sustainability, equity, and "competency-as-worldview."

**Suggested Revision:**
Further streamline selected sections of the introduction to improve readability and reduce conceptual redundancy while maintaining the strength of the argument.

**B. Study Design and Technical Soundness - Yes**
The authors have adequately addressed previous concerns regarding the study design. The justification for conducting EFA with a small sample size (n = 40) is now well-supported by relevant literature, and the inclusion of parallel analysis using Monte Carlo simulations strengthens the robustness of factor retention decisions. The DBR process has also been clearly elaborated, with detailed descriptions of iterative cycles and decision points.
**Suggested Revision:**
Reinforce within the findings section that the factor structure remains exploratory and context-bound to ensure cautious interpretation of results.

**C. Replicability of Methods - Yes**
This aspect has been substantially improved. The manuscript now provides the full set of instrument items, clearly identifies removed items along with statistical criteria, and offers a transparent and detailed description of the qualitative analysis process, including coding procedures, dual coding, and the audit trail. The justification for not using intercoder reliability metrics is also appropriately grounded in methodological literature.
**Suggested Revision:**

Consider presenting the qualitative coding process in a concise table or schematic diagram to enhance clarity and accessibility.

**D. Availability of Source Data - Yes**
The authors have maintained strong compliance with open science practices by providing datasets, instruments, and supplementary materials through ORDO. The clarification regarding ethical considerations and qualitative data availability is appropriate and enhances transparency.

**E. Statistical Analysis and Interpretation - Yes**
The statistical analysis is now robust and well-reported. The manuscript includes complete psychometric details such as factor loadings, communalities, eigenvalues, variance explained, KMO, Bartlett's test, and Cronbach's alpha. The addition of parallel analysis further strengthens the validity of the factor structure.
**Suggested Revision:**
Slightly streamline the presentation of statistical results to reduce repetition between tables and narrative explanations.

**F. Support of Conclusions by Results - Yes**
The conclusions are now more appropriately aligned with the results and are clearly framed as preliminary, context-bound, and part of a multi-phase research program. The distinction between empirical findings and forward-looking recommendations has improved.
**Suggested Revision:**
Further moderate a few statements implying broader institutional or global applicability to ensure consistency with the study's scope and sample limitations.

**Additional Suggestions**
(Optional but beneficial to the manuscript)
- The inclusion of the schematic model and implementation guidance is commendable; minor refinement for clarity and usability may further enhance practical application.
- Continue improving manuscript flow through minor reductions in dense sections and consistent use of clear subheadings.

**Overall Recommendation: Approve with Minor Revisions**
The revised manuscript demonstrates substantial improvement and successfully addresses the major concerns raised in the first review. It now presents a methodologically sound, conceptually coherent, and practically relevant contribution to researcher development literature. The remaining issues are minor and relate primarily to clarity, conciseness, and cautious interpretation.

**Evaluation**
**Is the work clearly and accurately presented and does it engage with the current literature?**
Yes
**Is the study design appropriate and is the work technically sound?**
Yes
**Are sufficient details of methods and analysis provided to allow replication by others?**
Yes
**Are all the source data and materials underlying the results available?**
Yes

**If applicable, is the statistical analysis and its interpretation appropriate?**
Yes
**Are the conclusions drawn adequately supported by the results?**
Yes

**References**
1. Garay-Argandona R, Rodriguez-Vargas M, Hernandez R, Carranza-Esteban R, et al.: Research competences in university students in virtual learning environments. *Cypriot Journal of Educational Sciences*. 2021; **16** (4): 1721-1736 Publisher Full Text

***Competing Interests:*** No competing interests were disclosed.

***Reviewer Expertise:*** My areas of expertise include educational research, researcher development, competency frameworks, mixed-methods research, and instrument development/validation. I am qualified to assess the conceptual framework, study design, statistical analysis (including factor analysis), qualitative methods, and overall methodological rigor. I am not an expert in domain-specific content outside the scope of researcher competencies (e.g., specific EU or UNESCO policy implementation), so my review focuses primarily on methodological and analytical aspects.

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.**

Author Response 28 Apr 2026

**Alexandra Okada**

We are grateful to the reviewer for the rigorous and constructive feedback.
Length and repetition. sections 1.1–1.2 have been tightened and overlapping passages in sections 3–5 consolidated. “Identity” usage has dropped from 58 to 20 occurrences; redundant summary paragraphs have been removed.
Framework deficiency. section 1.2 now acknowledges that the Vitae RDF, ResearchComp, and OECD Core Framework address purposes distinct from those of the eco-outwards framework. upSKILL.map is positioned as serving researchers engaged with societal, policy, or sustainability challenges — a constituency currently underserved by existing frameworks — not as a universal model. Disciplinary excellence, curiosity-driven inquiry, and fundamental science are explicitly recognised as equally valid research identities.
Sample size and psychometric claims. section 3.4 and section 4.1.3 state that n = 40 is below conventional thresholds and that the factor structure is descriptive and tentative, generating hypotheses for Phase-2 confirmatory testing (target n > 200, multi-institutional, pre-registered).
EFA/PCA distinction. EFA is retained as the methodological framing. PCA with Varimax rotation is specified as the extraction method appropriate for descriptive dimension reduction at this pilot stage (Tabachnick & Fidell, 2013; Costello & Osborne, 2005). Principal Axis Factoring (PAF) with Oblimin rotation has been added as a common-factor robustness check, reported in section 4.1.3: four of five components replicate stably; one (Collaborative Inclusive Leadership) shows method-dependence under oblique rotation. Common-factor EFA is reserved for Phase-2.

Relevance versus competence. We accept this distinction. Clarifying sentences in section 2.3 and section 3.4 state that Part-2 captures perceived relevance, not demonstrated competence. Phase-2 will pilot behaviourally-anchored items.
Self-selection. Within narrative inquiry, a self-selected sample of practitioners already engaged with the phenomenon is often more epistemically valuable than a large random sample (Clandinin & Connelly, 2000). Section 5.2 acknowledges the limits on generalisation while identifying three converging features that lend analytical weight to the findings.
Exploratory framing. The Abstract Results sentence now reads “converge on a five-factor descriptive clustering… as a baseline,” and its closing sentence specifies “further multi-institutional confirmation.” section 6 opens with “The claims below are theoretical syntheses informed by Phase-1 evidence; empirical generalisations await Phase-2 confirmation,” describes the five factors as “preliminary,” and closes with “offers a testable framework that, with multi-institutional replication, could inform research culture.”
Restricted claims and propositional recommendations. Sector-wide statements across sections 5–6 are qualified to the Phase-1 cohort. R1–R4 in section 5.5 now open with “Phase-1 findings suggest…,” “Phase-1 evidence suggests…,” “Phase-1 findings point to…,” and “Phase-1 competency profiles suggest…” — testable propositions rather than declarative claims.
Open science. All repository DOIs have been re-verified in the Data Availability section. SPSS syntax will be deposited prior to publication.
Theory–evidence separation. Theoretical arguments are flagged with “we argue” or “we propose”; empirical demonstrations are bounded to the Phase-1 cohort; hypothetical claims for Phase-2 testing are explicitly marked in section 5.4 and R1–R4.
We thank the reviewer for this careful and generous review

***Competing Interests:*** No competing interests were disclosed.

Reviewer Report 17 April 2026

https://doi.org/10.21956/openreseurope.25047.r72184

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**Moses Adeleke ADEOYE**
Al-Hikmah University, Ilorin, Nigeria

This manuscript addresses an important and timely issue: how researcher development frameworks might better prepare doctoral and early-career researchers for contemporary societal, environmental, and policy challenges.
The authors propose a new competency model (CARE–KNOW–DO), operationalised through the upSKILL.map self-assessment instrument, and report a Phase-1 validation study conducted at a UK university. The paper is ambitious, policy-relevant, and conceptually engaged with current debates on sustainability, responsible research and innovation, and researcher employability. It also

reflects a commendable commitment to open science and practical application. However, the manuscript currently combines a worthwhile conceptual agenda with methodological overreach, excessive length, blurred distinctions between theory and evidence, and stronger empirical claims than the data can sustain. The study should be understood as a promising exploratory pilot, not as a validated framework ready for broad implementation. The manuscript would benefit substantially from clearer structure, tighter writing, more cautious interpretation, and stronger methodological transparency.
The manuscript repeats key claims multiple times, especially regarding:
eco-outwards identity
sustainability/equity as foundational
aspiration–practice gap
CARE–KNOW–DO principles
This obscures the empirical contribution.
The manuscript sometimes assumes rather than demonstrates that current frameworks are deficient.
The paper should better acknowledge that:
Disciplinary excellence remains central to many research careers
Curiosity-driven/basic science is legitimate
Not all researchers need policy-facing competencies
Sample size too small for strong psychometric claims
n = 40 participants
28 retained items
five-factor solution
This is weak for stable factor extraction.
The manuscript refers to Exploratory Factor Analysis but uses Principal Component Analysis.
These are not identical methods. Participants appear to rate relevance/importance rather than demonstrated competence. Participants were likely predisposed toward sustainability and social impact agendas.
Reframe the study as a pilot exploratory validation only.
Clarify the statistical method precisely (PCA vs common factor EFA).
Avoid claiming validated competency measurement from self-report relevance ratings.
State limits of self-selection more prominently.
The manuscript references open materials and data repositories, which is positive. However, it is not fully clear whether all materials required to reproduce results are directly accessible.
Must Improve
Provide a direct repository DOI/URL.
Upload an anonymised quantitative dataset.
Provide codebook/data dictionary.
Provide analysis syntax/scripts.
Clarify access conditions for qualitative excerpts/data.
Rewrite the conclusion to emphasise exploratory status.
Restrict claims to this sample/context.
Present implementation suggestions as hypotheses for future study.

The manuscript must clearly state that findings represent preliminary exploratory evidence, not established validation. Specify whether PCA or common-factor EFA was conducted and justify the choice. Claims beyond this institution/sample should be reduced substantially. Provide data, items, coding framework, scripts, and repository links. Theoretical arguments about sustainability-

oriented research should be distinguished from what the study actually demonstrates empirically. This manuscript contains a promising and relevant contribution but currently overstates what can be concluded from a small exploratory pilot study. With substantial revision—especially clearer methodological framing, stronger transparency, reduced rhetorical overreach, and more cautious conclusions—it could become a valuable contribution to researcher development literature.

**Is the work clearly and accurately presented and does it engage with the current literature?**
Partly

**Is the study design appropriate and is the work technically sound?**
Partly

**Are sufficient details of methods and analysis provided to allow replication by others?**
Partly

**Are all the source data and materials underlying the results available?**
Partly

**If applicable, is the statistical analysis and its interpretation appropriate?**
Partly

**Are the conclusions drawn adequately supported by the results?**
Partly

***Competing Interests:*** No competing interests were disclosed.

***Reviewer Expertise:*** Educational Leadership, Research Methodology

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.**

Author Response 28 Apr 2026

**Alexandra Okada**

**Response to Reviewer 3 (Moses Adeleke ADEOYE)** *Manuscript: Developing Researchers' Competencies through CARE–KNOW–DO and upSKILL.map (Open Research Europe 2026, 5:333)* We are very grateful to the reviewer for the rigorous and constructive feedback. **Length and repetition.** sections 1.1–1.2 have been tightened and overlapping passages in sections 3–5 consolidated. “Identity” usage has dropped from 58 to 20 occurrences; redundant summary paragraphs have been removed. **Framework deficiency.** section 1.2 now acknowledges that the Vitae RDF, ResearchComp, and OECD Core Framework address purposes distinct from those of the eco-outwards framework. upSKILL.map is positioned as serving researchers engaged with societal, policy, or sustainability challenges — a constituency currently underserved by existing frameworks — not as a universal model. Disciplinary excellence, curiosity-driven inquiry, and fundamental science are explicitly

recognised as equally valid research identities. **Sample size and psychometric claims.** section 3.4 and section 4.1.3 state that n = 40 is below conventional thresholds and that the factor structure is descriptive and tentative, generating hypotheses for Phase-2 confirmatory testing (target n > 200, multi-institutional, pre-registered). **EFA/PCA distinction.** EFA is retained as the methodological framing. PCA with Varimax rotation is specified as the extraction method appropriate for descriptive dimension reduction at this pilot stage (Tabachnick & Fidell, 2013; Costello & Osborne, 2005). Principal Axis Factoring (PAF) with Oblimin rotation has been added as a common-factor robustness check, reported in section 4.1.3: four of five components replicate stably; one (Collaborative Inclusive Leadership) shows method-dependence under oblique rotation. Common-factor EFA is reserved for Phase-2. **Relevance versus competence.** We accept this distinction. Clarifying sentences in section 2.3 and section 3.4 state that Part-2 captures perceived relevance, not demonstrated competence. Phase-2 will pilot behaviourally-anchored items. **Self-selection.** Within narrative inquiry, a self-selected sample of practitioners already engaged with the phenomenon is often more epistemically valuable than a large random sample (Clandinin & Connelly, 2000). section 5.2 acknowledges the limits on generalisation while identifying three converging features that lend analytical weight to the findings. **Exploratory framing.** The Abstract Results sentence now reads *"converge on a five-factor descriptive clustering… as a baseline,"* and its closing sentence specifies *"further multi-institutional confirmation."* section 6 opens with *"The claims below are theoretical syntheses informed by Phase-1 evidence; empirical generalisations await Phase-2 confirmation,"* describes the five factors as *"preliminary,"* and closes with *"offers a testable framework that, with multi-institutional replication, could inform research culture."* **Restricted claims and propositional recommendations.** Sector-wide statements across sections 5–6 are qualified to the Phase-1 cohort. R1–R4 in section 5.5 now open with *"Phase-1 findings suggest…,"* *"Phase-1 evidence suggests…,"* *"Phase-1 findings point to…,"* and *"Phase-1 competency profiles suggest…"* — testable propositions rather than declarative claims. **Open science.** All repository DOIs have been re-verified in the Data Availability section. SPSS syntax will be deposited prior to publication. **Theory–evidence separation.** Theoretical arguments are flagged with *"we argue"* or *"we propose"*; empirical demonstrations are bounded to the Phase-1 cohort; hypothetical claims for Phase-2 testing are explicitly marked in section 5.4 and R1–R4.

***Competing Interests:*** No competing interests were disclosed.

Reviewer Response 04 Jun 2026

**Moses Adeleke Adeoye**

Accept the response from the author

***Competing Interests:*** No competing interests were disclosed.

**Version 1**

Reviewer Report 10 December 2025

https://doi.org/10.21956/openreseurope.23156.r63341

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**Mona Holmqvist**
Lund University, Malmö, Skåne County, Sweden

This article explores how researchers can contribute to sustainable, socially relevant solutions. The theory–practice gap is addressed, and the authors argue that future researchers are not adequately trained to address contemporary challenges. To improve this, an instrument (UpSkill.Map) has been developed and tested. In total, 28 skills based on the framework CARE-KNOW-DO have been investigated. The DO dimension is addressing applying skills through practice and societal engagement. The results show that there are challenges across several areas, including interdisciplinary engagement, impact translation, addressing urgent developmental needs, and training PhD students in these areas. The article is well written and covers an important topic, addressing what research is about and how it is enacted.

Furthermore, the instrument is evaluated both qualitatively and quantitatively. The participants belong to the same institution, and many of them are in the fields of wellbeing, education, and language (35.7%), which may affect the results. However, the authors address this, but not the intense interest this group has in the area studied, which might yield different results for participants in other fields. The quantitative analysis found that the most important skills were not in bridging the research gap, but rather in communicating the researcher's results. It is not problematized that we have difficulties disseminating research results, which might point to a limited need for the research as such. The questions about how researchers deliver results that support handling contemporary challenges, in relation to who defines the challenges, are not addressed.
Furthermore, at p. 11, "translate research into policy" points to a view of implementation as something to be negotiated, and thereby gives the impression that it is not negotiated in the context where the results are planned to be used. This might be elaborated on further. At p. 13, Box 1, the challenge of aligning research with society is also mentioned. The authors suggest that there should be more training for researchers and PhD students to communicate research results outside academia; however, the question of how the research is situated and addresses societal challenges is not discussed. Societally engaged research grounded with and for society could have been addressed more thoroughly. This is also lacking in the recommendations at p 19, where all five suggestions address the academic environment but not the societal challenges and how to make an impact in practice. The authors also discuss translating research (p. 19) rather than practice- or society-embedded research.

Nevertheless, the instrument UpSkill. Map could be more focused on how to address and negotiate the research focus with society and the challenges encountered in practice when planning research instead of afterwards. This was not tested in the study; however, it could be discussed as a further development, as the qualitative analysis points to such difficulties. Maybe

the authors might benefit of reading the special issue “Real impact”: Challenges and opportunities in bridging the gap between research and practice – Making a difference in industry, policy, and society (Ref 1)

**References**

1. Dwivedi Y, Jeyaraj A, Hughes L, Davies G, et al.: “Real impact”: Challenges and opportunities in bridging the gap between research and practice – Making a difference in industry, policy, and society. *International Journal of Information Management*. 2024; **78**. Publisher Full Text

**Is the work clearly and accurately presented and does it engage with the current literature?**
Yes

**Is the study design appropriate and is the work technically sound?**
Yes

**Are sufficient details of methods and analysis provided to allow replication by others?**
Yes

**Are all the source data and materials underlying the results available?**
Yes

**If applicable, is the statistical analysis and its interpretation appropriate?**
I cannot comment. A qualified statistician is required.

**Are the conclusions drawn adequately supported by the results?**
Yes

***Competing Interests:*** No competing interests were disclosed.

***Reviewer Expertise:*** Higher education, research leadership, doctoral supervision and courses, teaching and learning.

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.**

Reviewer Report 25 November 2025

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**Amelie E Trinidad**

Davao del Sur State College, Matti, Digos City, Davao del Sur, Philippines

**Review Report**

**Manuscript Title:** *Developing Researchers' Competencies through CARE–KNOW–DO and upSkill.Map, aligned with EU and UNESCO Priorities*
**Authors:** Okada A., Sheehy K., Dieter Rossade K., & Bandara A.K.
**Overall Recommendation: Approved with Reservations**

**A. Clarity and Engagement with Literature - Partly**
The manuscript is conceptually well-grounded and draws on a broad range of up-to-date literature on researcher development, responsible research and innovation (RRI), sustainability, and equity. The theoretical integration is commendable. However, the introduction is lengthy and contains some repetition. A more concise articulation of the study's unique contribution relative to existing frameworks (e.g., RMComp, Open Science Skills Framework) would strengthen the argument. More explicit clarification of the instrument's novel added value is encouraged.

**Suggested Revision:**
Condense the introduction and clearly articulate how *upSkill.Map* advances or complements existing competency frameworks.

**B. Study Design and Technical Soundness - Partly**
The use of design-based research (DBR) is appropriate for iterative instrument development, and the combination of quantitative and qualitative strategies enhances methodological depth. However, several issues arise in the quantitative phase:

- The EFA is based on **n = 40**, a very small sample for stable factor extraction.
- No supplemental procedures (e.g., parallel analysis, MAP test, bootstrapping) are reported to support factor retention.
- The DBR cycles would benefit from more detailed operational description.

**Suggested Revisions:**

- Provide methodological justification for conducting EFA with a small sample, supported by relevant literature.
- Report at least a parallel analysis or justify its omission.
- Elaborate on the DBR process by specifying the decisions and iterative refinements across cycles.

**C. Replicability of Methods - Partly**
While the general analytical approach is described, several essential details are missing:

- The full set of original instrument items is not provided.
- Items removed during EFA are not explicitly identified.
- The qualitative analysis lacks transparency regarding coding process, number of coders, intercoder reliability, and theme development.

**Suggested Revisions:**

- Provide the complete original item list in an appendix or supplemental file.
- Identify the removed items and indicate the statistical criteria for removal (e.g., low factor

loadings, low communalities).
- Expand the qualitative methods section by clarifying coder roles, coding procedures, agreement metrics, and the analytical audit trail.

**D. Availability of Source Data - Yes**
The authors provide complete datasets and associated materials through ORDO. This is commendable and fully aligned with ORE's open-science requirements. A brief clarification regarding whether qualitative excerpts are available or subject to ethical restrictions would enhance transparency.

**E. Statistical Analysis and Interpretation - Partly**
The statistical approach is appropriate, but the reporting lacks necessary detail for methodological robustness:
- Full EFA results (factor loadings, communalities, eigenvalues, variance explained) are not included.
- The limitations of the small sample size are not sufficiently acknowledged.

**Suggested Revisions:**
- Include full EFA tables and diagnostic outputs.
- Explicitly discuss the potential instability of the factor solution due to sample size.
- Conduct (or explain the absence of) additional checks such as parallel analysis.

**F. Support of Conclusions by Results - Partly**
The conclusions generally align with the findings and the conceptual grounding of the study. However, some claims imply broader institutional or sector-level implications that may not be fully supported by this preliminary dataset
.
**Suggested Revision:**
Reframe the conclusions to avoid overstating generalizability and clearly differentiate empirical findings from aspirational or theoretical recommendations.

**Additional Suggestions**
*(Optional but beneficial to the manuscript)*
- Add a schematic model illustrating relationships among the CARE–KNOW–DO components, the 8Cs, and the derived factors.
- Provide a concise implementation guide to help institutions adopt *upSkill.Map*.
- Streamline the manuscript through improved sectioning and clear subheadings.

**Overall Recommendation: Approve with Minor Revisions**
This study represents a valuable and timely contribution to researcher development and aligns well with European and UNESCO-linked priorities. Addressing the methodological and reporting issues noted above will substantially enhance the manuscript's clarity, rigour, and broader impact.

**Is the work clearly and accurately presented and does it engage with the current literature?**
Partly

**Is the study design appropriate and is the work technically sound?**

Partly

**Are sufficient details of methods and analysis provided to allow replication by others?**
Yes

**Are all the source data and materials underlying the results available?**
Partly

**If applicable, is the statistical analysis and its interpretation appropriate?**
Partly

**Are the conclusions drawn adequately supported by the results?**
Partly

***Competing Interests:*** No competing interests were disclosed.

***Reviewer Expertise:*** My areas of expertise include educational research, researcher development, competency frameworks, mixed-methods research, and instrument development/validation. I am qualified to assess the conceptual framework, study design, statistical analysis (including factor analysis), qualitative methods, and overall methodological rigor. I am not an expert in domain-specific content outside the scope of researcher competencies (e.g., specific EU or UNESCO policy implementation), so my review focuses primarily on methodological and analytical aspects.

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.**

Author Response 10 Feb 2026

**Alexandra Okada**

REQUEST CHANGES:
Condense the introduction and clearly articulate how *upskill. Map* advances or complements existing competency frameworks.

A. Clarity and Engagement with Literature
✓ Addressed: New introduction with clear articulation of how upSkill.Map advances existing frameworks
✓ Added comparative Table 1 showing distinctions between ResearchComp, Vitae RDF, OECD Framework, and upSkill.Map o
✓ Enhanced theoretical contribution explanation (Section 1.3) Provide methodological justification for conducting EFA with a small sample, supported by relevant literature. Report at least a parallel analysis or justify its omission. Elaborate on the DBR process by specifying the decisions and iterative refinements across cycles.

B. Study Design and Technical Soundness
✓ Addressed: Expanded methodological justification for small sample EFA (n=40)

✓ Added detailed justification with relevant literature references
✓ Included parallel analysis results with 1,000 Monte Carlo simulations
✓ Added explicit acknowledgment of sample size limitations
✓ DBR process expanded with explanations Provide the complete original item list in an appendix or supplemental file. Identify the removed items and indicate the statistical criteria for removal (e.g., low factor loadings, low communalities). Expand the qualitative methods section by clarifying coder roles, coding procedures, agreement metrics, and the analytical audit trail.

C. Replicability of Methods
✓ Addressed: Provided complete original 32-item instrument list in appendix
✓ Identified four removed items with specific statistical criteria (communalities <0.30, cross-loadings >0.47)
✓ Expanded qualitative methods section with coder roles, coding procedures, audit trail documentation The authors provide complete datasets and associated materials through ORDO. This is commendable and fully aligned with ORE's open-science requirements. A brief clarification regarding whether qualitative excerpts are available or subject to ethical restrictions would enhance transparency.

D. Source Data Availability
✓ Confirmed: Complete datasets available via ORDO
✓ Clarified that qualitative excerpts are available in the database Full EFA results (factor loadings, communalities, eigenvalues, variance explained) are not included.

E. Statistical Analysis and Interpretation
✓ Addressed: Included full EFA tables and diagnostic outputs in appendix
✓ Explicitly discussed potential instability due to small sample size
✓ Added parallel analysis justification
✓ Provided detailed variance explanation (75.69% total; individual factors: 19.83%, 16.23%, 14.47%, 13.47%, 11.69%)

The conclusions generally align with the findings and the conceptual grounding of the study. However, some claims imply broader institutional or sector-level implications that may not be fully supported by this preliminary dataset

F. Support of Conclusions
- ✓ Addressed: Reframed conclusions to avoid overstating generalizability
- ✓ Differentiated empirical findings from aspirational recommendations
- ✓ Clarified preliminary validation stage of research

Additional Enhancements Made (Beyond Reviewer Questions)
- ✓ Added schematic model illustration relationships among CARE–KNOW–DO, 8Cs, and derived factors
- ✓ Provided implementation guide for institutional adoption
- ✓ Improved sectioning and clearer subheadings throughout
- ✓ Enhanced DBR process description with specific details on iterative refinements

across cycles.

***Competing Interests:*** No competing interests were disclosed.