Designing Industry-Aligned Advanced Digital Skills Curricula: Evidence from Digital4Business, a Pan-European Online Master's Programme

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Abstract. Advanced digital skills shortages continue to challenge European industry despite sustained expansion of postgraduate computing education. Previous research has identified misalignment between academic provision and industry needs, but scant work has examined how curricula can be systematically designed, aligned, and accredited across institutions and national contexts. This paper presents a fully online pan-European Master's programme developed using a design-based research approach under the Digital4Business project. Based on empirical needs analysis and co-designed with industry partners, the programme integrates modular curricula, challenge-based learning, and embedded professional certifications across multiple institutions. We report verifiable evidence drawn from the structure of the programme, module availability, enrolment data, delivery capacity, accreditation artefacts, and initial cohort characteristics, including demographic distributions and student participation patterns. We demonstrate how scale, curricular flexibility, and cross-institutional delivery provide early evidence of sustained student participation and industry alignment. The paper contributes practical insights for computing education practitioners designing transnational, modular, and professionally aligned postgraduate programmes.

Keywords: Computing Education Research · Design-based Research · Postgraduate Education · Industry Alignment · Advanced Digital Skills

1 Introduction

Advanced digital skills (ADS) comprise a set of specialised competencies that extend beyond foundational computing knowledge. Although digital skills (often framed as digital skills of the 21st-century) are commonly conceptualised in dimensions such as technical proficiency, information management, communication, collaboration, critical thinking, creativity, and problem-solving [8], their classification as *advanced* depends primarily on the incorporation of modern technologies. Such technologies facilitate a more granular understanding of digital tools, platforms, and underlying computational concepts, and, consequently, ADS are frequently characterised and labelled according to the specific technologies that underpin them.

ADS in commercially relevant areas such as cloud computing, cybersecurity, data engineering, and artificial intelligence are increasingly critical to economic competitiveness and organisational resilience [9]. However, employers across Europe continue to report difficulty recruiting graduates with applied competence and job-ready skills. This gap persists even as postgraduate computing education expands, suggesting that provision alone is insufficient without attention to curriculum relevance, pedagogical authenticity, and sustainable delivery models. Recent work also emphasises the importance of incorporating early empirical indicators, including learner characteristics and participation patterns, to substantiate claims of alignment with industry needs.

Computing education research has generated robust evidence on undergraduate teaching and learning for ADS [11], including programming pedagogy, assessment, and analytics-informed interventions [7]. In contrast, postgraduate education–particularly for professional learners and at the cross-institutional scale–arguably remains underexamined. However, postgraduate education is frequently the place where advanced specialisation, professional identity development, and industry transition are most prominent.

As a multi-million Euro ground-breaking project with 15 academic, industry, and government partners located in 7 European countries, the Digital4Business project responds to an identified need for ADS in the European industry. By conducting systematic needs analyses between organisations and stakeholders following commercial practices [15], the project has identified both high-demand technical areas and cross-functional competence needs relevant for the development of an ADS-centric postgraduate higher education programme. Industry stakeholders are involved not only in advisory or recruitment roles, but also in curriculum co-design, delivery input, and assessment calibration, providing a direct mechanism for aligning educational provision with labour market expectations.

Organically incorporating security-by-design, cloud-native thinking, data stewardship, and professional practices, the Digital4Business project has designed an online Master's degree accredited as a joint European degree. Formally titled "Joint Professional Master's in Advanced Digital Technologies for Business", its learning modules have been developed through structured needs analysis and industry co-design. Consequently, this paper extends our initial work [5,13] by describing our *Design-based Research* (DBR) approach to investigate how industry-aligned ADS postgraduate computing curricula can be devised and implemented across institutional boundaries. In addition to programme design and structure, this paper incorporates early empirical evidence from the first delivery cycle of the Master's, including enrolment data and demographic distributions of students (Section 5), providing initial indications of how industry-informed design is reflected in the composition and participation of the learners.

1.1 Research Contributions

This paper makes two main contributions to computing education research:

- **Design knowledge**: Transferable design principles for scalable cross-institutional postgraduate computing education (governance, alignment, scaffolding, and digital infrastructure).
- **Methodological contribution**: A practical DBR-informed evaluation approach for complex programme interventions combining curricular, organisational, and platform dimensions.

2 Related Work

Constructive alignment brings together two influential strands in contemporary higher education practice: constructivist learning theory and instructional design [1]. From a constructivist perspective, learning is understood as an active process in which students generate meaning through engagement and purposeful activity. This view shifts attention away from what teachers deliver and towards what learners do, implying that teaching should be designed to support meaningful learning experiences and that assessment should capture the quality of student thinking rather than surface recall.

In contrast, *instructional design* has traditionally emphasised coherence between curriculum objectives and assessment criteria. Constructive alignment integrates these concerns using constructivism as a guiding framework for curriculum planning and evaluation. It begins by specifying learning outcomes in terms of high-level understanding performances, then selecting teaching and learning activities that are likely to elicit those performances, and finally designing assessment tasks that validly measure them. In this way, objectives, learning activities, and assessment are systematically aligned to support deeper learning and consistent standards across courses and programmes.

Historically, it has long been crucial to incorporate such concepts into computing education [2,6], where curriculum relevance, skills, and industry alignment have been long-standing concerns [4,12]. Work-integrated learning and authentic assessment approaches are associated with increased learner motivation and perceptions of employability, yet they can be difficult to scale due to assessment calibration and partner availability [10].

A methodological paradigm that emphasises iterative design, implementation, analysis, and refinement of interventions situated in authentic contexts, DBR is used to study complex educational interventions, particularly where iterative refinement and ecological validity are central, using standard classrooms with average students and teachers. In computing education, DBR has been applied to curriculum innovations and technology-enhanced learning contexts, supporting analytical generalisation and project-based learning through rich description and principled design rationales [14].

DBR is particularly suited to programmes that combine curricular, organisational, and platform components because:

- **Complexity**: multiple interacting variables cannot be isolated without undermining ecological validity.
- **Iterativity**: early delivery cycles inform actionable refinements.
- **Design knowledge**: outcomes are translated into transferable principles rather than solely local optimisation.

2.1 Research Contribution

Within Digital4Business, a comprehensive needs analysis [13] and programme design [5] have established the empirical grounding and curricular intent for a joint Master's degree in ADS accredited at European level. The present study extends our previous work by investigating *enactment* (delivery in practice) and *learning experience* (learner perceptions, engagement, and cross-institutional challenges), generating initial

Table 1. Core Programme Design Components

Component	Description
Industry co-design	Curriculum scope, scenarios, and assessment expectations specified with industry partners and advisory input.
Modular structure	Stackable modules with credit-bearing pathways and optional embedded professional certifications.
Challenge-based learning	Authentic industry scenarios and projects integrating technical and professional competencies.
Cross-institutional delivery	Shared modules and teaching across multiple HEIs with harmonised outcomes and rubrics.
Digital platform	Shared LMS, cloud labs, collaboration tools, and analytics for monitoring and support.

empirical evidence and design principles relevant to the computer science education community.

Our work is grounded in DBR and its pedagogical design is informed by constructive alignment. Specifically, constructive alignment motivates explicit mapping between learning outcomes, tasks, and assessment rubrics, a key need in cross-institutional delivery. DBR motivates challenge-based projects grounded in industry scenarios, requiring learners to integrate conceptual knowledge with professional practices and constraints.

3 Programme Design

The Digital4Business Master's has been designed around five interdependent components (Table 1) and implemented through a shared digital infrastructure. The programme delivers a joint Master's degree at EQF Level 7, requiring successful completion of 60 ECTS credits. The delivery is collaboratively offered online by four European higher education institutions, each contributing discipline-specific module aligned with institutional expertise, namely National College of Ireland, Università di Bologna, Linköpings Universitet, and Universidade Nova de Lisboa.

The programme is offered in three study modes: *Full-Time (2 semesters), Part-Time Accelerated (3 semesters),* and *Part-Time (4 semesters).* All study modes lead to the same accredited award and learning outcomes, ensuring equivalence across flexible delivery formats.

Curriculum Structure and Competency Coverage The Digital4Business Master's curriculum, designed to provide students with a comprehensive training in advanced digital skills, includes fourteen modules, as shown in Table 2. Each module combines theoretical insights with practical applications, ensuring that students acquire competencies that are directly applicable in the industry.

A central design principle of the programme is modular flexibility. One mandatory module, *Digital Transformation* (10 ECTS), anchors the curriculum. The students then select 40 ECTS credits from a suite of elective modules that span both computing and

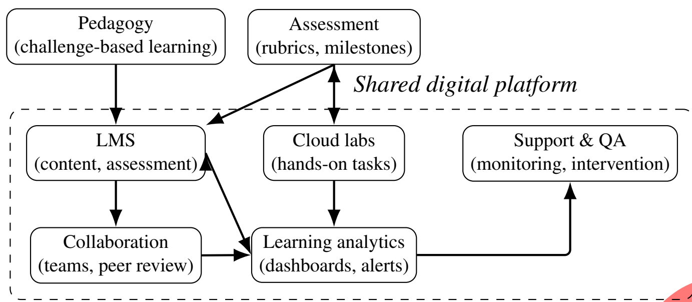

Fig. 1. Platform-enabled delivery: connections between pedagogy, assessment, and learner support.

Table 2. Fourteen Modules in the Digital4Business Master's Programme

Module Name	ECTS Cred.	Description
Digital Transformation	10	Core course covering the fundamentals of digital transformation and business applications
AI for Business	10	Elective module focusing on machine learning applications and AI ethics in business
Data Science for Business	10	Data science tools and methods, including data analysis, visualisation, and business intelligence
Cybersecurity for Business	10	Key cybersecurity strategies, risk management, and data protection techniques
Cloud Computing for Business	10	Implementation and management of cloud-based solutions in enterprise settings
Business Programming	5	Introduction to programming for business, focusing on productivity tools
Internet of Things (IoT)	5	IoT fundamentals and applications in business contexts
Blockchain Technologies	5	Overview of blockchain and its transformative impact on digital infrastructure
Quantum Computing	5	Fundamentals of quantum computing and its potential in future digital landscapes
Data Governance and Ethics	5	Data management and ethics within digital transformation
Innovation	5	Exploring the innovation lifecycle and strategies for digital businesses
Generative AI	5	Applications and implications of generative AI for creativity and productivity
Risk and Change Management	5	Managing risks and change in digital business environments
Digital Transformation Project	10	Capstone artefact for applying learned skills to a practical challenge

business-orientated digital skills. The final mandatory module is the *Digital Transformation Project* , which provides a capstone learning artefact to showcase the acquired ADS at EQF Level 7. The programme adopts a modular structure to support part-time professional learners and to enable recognition of prior experiential learning. Modules are organised around technical domains and cross-cutting capabilities. Table 3 illustrates a representative mapping from high-level competency areas to module design intentions and evidence sources.

Table 3. Illustrative Competency-to-Module Mapping and Alignment Evidence

Competency area	**Module design intention**	**Alignment evidence and artefacts**
Cloud-native engineering	Infrastructure-as-code, observability, resilience patterns	Cloud lab tasks; milestone-based rubrics; artefact portfolio
Cybersecurity	Secure design, threat modelling, controls and compliance	Scenario-based assessment; security review reports; incident response drill
Data engineering & analytics	Data pipelines, governance, reproducibility	ETL project; data quality checks; reflective technical log
AI & responsible use	Model evaluation, risk, and deployment constraints	Case analysis; model card artefacts; stakeholder briefings
Professional practice	Requirements, communication, ethics, teamwork	Peer review protocol; sprint retrospectives; professional reflection

3.1 Accreditation

The Master's programme has obtained the EQAR (European Quality Assurance Register for Higher Education) accreditation. This recognition validates the quality of the programme and enhances its international credibility. This EQAR accreditation signifies:

- **Recognition Across Europe**: Accreditation based on the European Approach ensures programme acceptance across the European Higher Education Area without additional national criteria, promoting student mobility and career opportunities.
- **Alignment with European Standards**: The programme adheres to the Standards and Guidelines for Quality Assurance in the European Higher Education Area, ensuring transparent and comprehensive quality assurance.
- **Commitment to Quality and Excellence**: Accreditation confirms the commitment of Digital4Business to high-quality education aligned with the Qualifications Framework for the European Higher Education Area (QF-EHEA).

All 10 ECTS modules have also been certified at European level as micro-credentials and can be offered as single modules to those learners interested in specific ADS areas given that the curriculum integrates industry-aligned content and pathways towards recognised professional certifications, strengthening relevance for learners in employment contexts.

3.2 Assessment Model

The assessment is designed to be authentic and cumulatively evidential. Across modules, students produce technical artefacts (code, infrastructure definitions, reports) and reflective components (rationales, post-mortems). A common assessment pattern is:

- **Milestones**: low-stakes submissions to scaffold progress and reduce end-loading.
- **Capstone artefact**: integrated project output evaluated with a rubric aligned to outcomes.
- **Reflection**: structured reflection linking decisions to constraints, risks, and stakeholder needs.

This structure supports constructive alignment and provides evidence for academic and professional competency claims.

3.3 Digital Platform and Delivery Infrastructure

Figure 1 shows the platform as an enabling layer connecting pedagogy, assessment, and support. The platform integrates an LMS, cloud laboratory environment, collaboration tooling, and analytics dashboards used for learner support and quality assurance.

Lectures are given asynchronously and complemented by laboratories and tutorials demonstrated synchronously. While the full Master's programme is to be undertaken online by learners across Europe, there are some optional face-to-face networking activities organised in different countries by industry partners.

4 Methodology & Evaluation

A mixed-methods DBR methodology has been adopted that encompasses problem analysis, design, implementation, and evaluation with iterative refinement. The present paper reports primarily on the first full delivery cycle, with evaluation oriented towards generating design knowledge and informing refinement, rather than claiming causal effects.

Rather than asserting participation abstractly, we report verified enrolment data from the September 2025 intake. A total of 53 learners were enroled across multiple pathways, including full-time, part-time, accelerated, postgraduate certificate, micro-credential, and continuing learners.

Module-level enrolment data demonstrate a sustained demand for AI-oriented content. The highest concentrations were observed in *AI for Business, Generative AI,* and *Digital Transformation.*

The participation spans learners from more than 15 European countries, confirming the pan-European reach of the programme. The gender distribution (57% male, 41% female, 2% undisclosed) indicates an improvement in balance compared to previous pilot cohorts.

Additionally, we are in the process of providing objective indicators of participation at both the programme and module levels, supporting claims of sustained participation of the learner without reliance on self-reported engagement metrics, as illustrated in Table 4.

Table 4. Evaluation Data Sources and Intended Inferences

Data source	Measures / artefacts	Intended inference
Learner surveys (pre/post)	Relevance, coherence, workload, self-efficacy, satisfaction	Perceived alignment; perceived value; tensions (e.g., workload)
Learning analytics	Logins, submissions, milestone completion, forum activity	Engagement patterns; pacing; risk indicators
Staff reflective memos	Delivery notes, assessment issues, support interventions	Implementation barriers/enablers; governance needs
Industry assessor feedback	Assessment quality, expectations, artefact realism	Authenticity; industry/academic calibration
Artefact sampling	Rubric-scored deliverables and reflections	Evidence of outcome attainment and authenticity

Table 5. Cross-Institutional Themes and Implications

Theme	Description	Implication
Assessment calibration	Differences in grading norms and feedback expectations across institutions	Shared rubrics, exemplars, and moderation checkpoints
Workload alignment	Authentic tasks varied in effort depending on learner prior knowledge	Diagnostic onboarding; tiered scaffolding; explicit workload budgeting
Coordination overhead	Scheduling, tool access, and communications across partners	Central timetable, platform integration, and role clarity

We are acquiring quantitative survey data to identify patterns in modules and cohorts. Analytics are used at the level of weekly participation and milestone completion to identify pacing effects and risk points for attrition. The initial qualitative data has been analysed using thematic analysis.

The evaluation processes follow standard educational evaluation practices: voluntary participation, anonymised reporting of learner data, and separation of evaluation from grading decisions where feasible. Given the programme setting, the emphasis is on analytical generalisation through transparent context description and triangulation, rather than statistical generalisation.

We are particularly interested in two behavioural patterns:

- **Pacing effects**: milestone deadlines as a determinant of engagement to eventually reduce last-minute submission spikes.
- **Support effects**: short-term increases in platform activity, especially among learners with a lower prior experience.

These patterns align with the constructive alignment goal of linking activities and assessment transparently, and they support authentic learning only when adequate scaffolding is provided.

It is noted that initial staff reflections and industry assessor feedback have converged on three key themes: governance, calibration, and operational coordination. Table 5 summarises themes and representative implications.

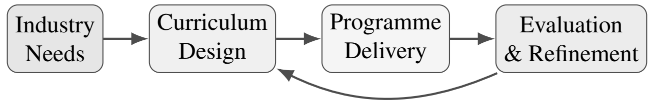

Fig. 2. Design-based research cycle used to connect needs analysis, design, enactment, and refinement.

Industry assessors valued artefact realism, but highlighted the need for explicit calibration between “professional sufficiency” and “academic excellence”. This tension is typical in industry-aligned programmes and supports the need for transparent rubrics and exemplars.

Figure 2 conceptualises how the evaluation findings will inform iterative refinement. In practice, refinements after the first cycle included: (i) tightening milestone schedules; (ii) introducing a short diagnostic task to tailor scaffolding; and (iii) establishing a cross-institution moderation meeting per module.

5 Industry Engagement and Demographic Evidence

A central question in evaluating industry-aligned curricula concerns not only how industry contributes to programme design, but also how such engagement is reflected in the composition and behaviour of enroled learners. The first cohort, fully open to the public, was launched in September 2025, comprising 25 continuing learners and 26 newly admitted students (total $n = 51$), providing a robust empirical basis to examine this relationship. This cohort represents the first fully mature intake shaped by iterative refinements and strengthened industry integration.

From a structural perspective, industry participation extends beyond advisory functions into co-design, delivery, and assessment. Industry stakeholders contribute to the definition of competency priorities in areas such as AI, cybersecurity, cloud computing, and data science. These areas correspond directly to domains identified as critical shortages within the European labour market, where demand for advanced digital skills continues to outpace supply. This alignment is operationalised through challenge-based learning, mentoring schemes, and direct involvement of industry experts in assessment processes.

The influence of this integration is observable in the demographic composition of the consolidated cohort. The inclusion of 25 continuing learners alongside new entrants reflects a programme structure that supports both progression and reskilling. Importantly, the new entry group includes a significant proportion of individuals with prior postgraduate qualifications, indicating that the programme attracts professionals seeking to update competencies in response to evolving industry requirements. When combined with continuing learners, this results in a cohort characterised by a mix of early-career and mid-career participants, reinforcing the role of the programme within lifelong learning pathways.

In terms of disciplinary background, Figure 3 shows that the cohort exhibits substantial heterogeneity. Although computing-related disciplines (computer science, informatics, and software engineering) remain strongly represented, there is also a notable presence of learners from business, economics, and interdisciplinary domains.

This distribution reflects the increasing demand for hybrid professional profiles capable of integrating technical expertise with organisational and strategic competencies. The presence of such profiles within the cohort can be interpreted as indirect evidence of industry signalling, allowing learners to align their educational choices with perceived employment opportunities.

As shown in Figure 4, the gender distribution within the consolidated cohort indicates incremental improvement relative to traditional ICT education patterns, although an imbalance persists. Based on aggregated proportions, approximately 57% of learners identify as male and 41% as female, with a small proportion undisclosed. Although not yet parity has been achieved, this distribution compares favourably with European benchmarks for ICT participation and suggests that programme design and outreach strategies may contribute to greater inclusion.

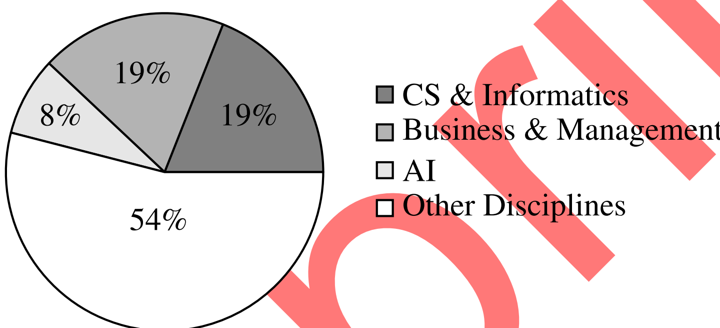

Fig. 3. Disciplinary background distribution of new students in the September 2025 cohort ($n = 26$). Each slice is reported as a percentage of the new-student subgroup.

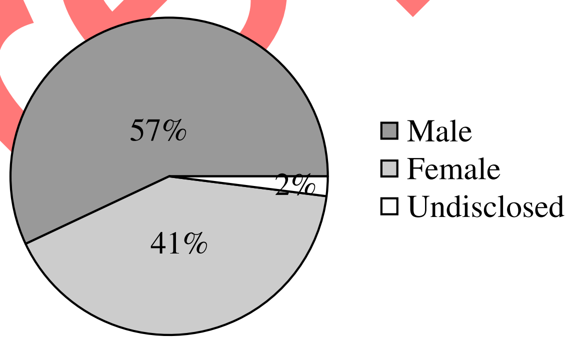

Fig. 4. Gender distribution of the consolidated September 2025 cohort ($n = 51$). Each slice is reported as a percentage of the full consolidated cohort.

Figures 3 and 4 highlight two key observations. First, the diversity of disciplinary backgrounds reinforces the interdisciplinary positioning of the programme, which is consistent with industry demand for cross-functional skills sets. Second, while the gender imbalance remains, the relative increase in female participation suggests positive movement compared to the baseline ICT education statistics.

Beyond static demographics, the interaction between industry participation and learner behaviour is also reflected in module selection patterns. Modules with strong industry relevance, particularly those focused on artificial intelligence and digital transformation, attract the highest levels of participation. This indicates that learners are making strategic educational choices aligned with employment outcomes, further reinforcing the effectiveness of industry-informed curriculum design.

Industry involvement also contributes to the calibration of the assessment. Feedback from industry assessors highlights a productive tension between academic expectations and professional practice, particularly with respect to the balance between methodological rigour and practical sufficiency. Addressing this tension requires shared rubrics, exemplars, and moderation processes between institutions. Importantly, this calibration improves the credibility of the programme by ensuring that the assessment outcomes are meaningful in both academic and professional contexts.

From a systems perspective, the consolidated cohort provides evidence of a feedback loop that links industry demand, curriculum design, and learning participation. Industry input shapes programme content and delivery, which in turn attracts a demographically and professionally diverse cohort aligned with labour market needs. Graduates emerging from this system are therefore positioned to contribute directly to addressing the advanced digital skills gap, reinforcing the alignment cycle.

In conclusion, the consolidated cohort for September 2025 shows that structured industry engagement produces measurable effects not only in curriculum design but also in student composition and behaviour. The observed demographic diversity, reskilling orientation, and alignment with high-demand domains provide empirical support for positioning industry collaboration as a core design principle in scalable postgraduate computing education.

Discussion From a DBR perspective, the intended findings should ideally illustrate how an intervention can generate design knowledge while improving practice. The high perceived relevance and authenticity support the principles of authentic learning. However, authenticity also introduces complexity and variability in the required effort, explaining workload concerns. This tension suggests a need for structured scaffolding that preserves authenticity while supporting diverse backgrounds of admission.

Constructive alignment offers a coherent explanation for observed engagement differences: modules with clearer alignment between outcomes, milestones, and rubrics sustained engagement more effectively. In inter-institution settings, alignment must be maintained not only at the module level but also in governance processes, including moderation and shared exemplars.

Synthesising evidence across data sources, we propose the following design principles (DPs) as transferable contributions:

– **DP1: scope of Evidence-based curriculum**. Start with a systematic needs analysis and maintain an explicit trace from competencies to module outcomes and assessments.

- **DP2: Authenticity with scaffolding**. Use industry scenarios but support learners through diagnostics, milestones, and structured clinics to manage heterogeneous previous experience.
- **DP3: Cross-institution assessment calibration**. Establish shared rubrics, examples, and moderation checkpoints to ensure consistency and fairness.
- **DP4: Platform as a pedagogical infrastructure**. Treat the digital platform as an enabling layer for pedagogy, assessment, and support, not as merely a delivery channel.
- **DP5: Governance for iterativity**. Formalise iterative refinement through DBR cycles, including mechanisms to capture issues, decide changes, and evaluate results [3,16].

This work arguably contributes evidence on postgraduate and professional learning contexts, an under-represented area relative to undergraduate CS education. It also demonstrates a researchable approach to programme-scale interventions where organisational and platform aspects are integral to learning outcomes.

Limitations The findings are based on a particular pan-European initiative, including specific partner configurations, platform tools, and module choices. Although DBR aims for analytical generalisation, it remains possible that some design tensions (e.g., workload perceptions) manifest differently in programmes with alternative learner profiles or regulatory contexts.

Learners self-select to become a professional Master's and can display higher intrinsic motivation and tolerance for ambiguity than the general population. This may inflate perceived relevance and satisfaction ratings. Future studies should examine how the design performs with broader recruitment strategies and under-represented groups.

The evaluation focuses on early delivery cycles. Key outcomes such as job mobility, employer-recognised competence, and durable skill transfer require longitudinal evidence. Short-cycle metrics, including analytics and immediate perceptions, may not capture delayed benefits or later friction.

Engagement analytics will provide a behavioural proxy, but not direct evidence, of learning quality. Artefact sampling begins to address this, yet deeper learning process data (e.g., design rationale quality, conceptual change, collaborative knowledge building) will unfortunately remain under-measured.

6 Conclusions

This paper presented a design-based computing education research study of a pan-European online Master's programme in advanced digital skills. By integrating empirical needs analysis, industry co-design, constructive alignment, and mixed-methods evaluation, the study contributes evidence-based insights into scalable postgraduate computing education. The proposed design principles and future research agenda provide a basis for strengthening both practice and theory in industry-aligned computing education.

It extends computing education research into postgraduate and professional learning contexts and demonstrates how DBR can be operationalised in cross-institution initiatives. The design principles and methodological approach reported here support analytical generalisation and provide a foundation for future comparative, longitudinal, and equity-focused studies.

6.1 Future Research Agenda

We propose five research directions, each aligned with a limitation and aimed at generating stronger contributions:

FR1: Longitudinal outcomes and skill transfer. Track cohorts throughout programme completion and into employment to examine (i) perceived competence; (ii) employer feedback; and (iii) objective indicators such as role changes, responsibilities, and professional certification attainment. This would allow for examination of sustained transfer and development of professional identity.

FR2: Comparative evaluation of scaffolding strategies. Conduct quasi-experimental or comparative DBR iterations comparing scaffolding variants (e.g., diagnostic-based pathways, tiered lab difficulty, optional bootcamps) to determine which strategies best support heterogeneous entrants without diluting authenticity.

FR3: Cross-institution assessment reliability studies. Apply moderation and rubric calibration research designs to measure inter-rater agreement and explore how exemplars, assessor training, and rubric precision affect fairness and feedback quality across institutions and industry assessors.

FR4: Process-focused learning analytics. Extend analytics beyond participation in learning processes, using event sequences, milestone trajectories, and artefact metadata to investigate self-regulation, procrastination patterns, and support interventions. The combination of analytics with qualitative learning journals could improve interpretability.

FR5: Equity, inclusion, and accessibility in professional online postgraduate computing. Examine participation barriers, accessibility needs, and differential impacts of scheduling, synchronous elements, and prerequisite assumptions. This direction is critical to ensure that scalable programmes broaden participation rather than amplify existing inequities.

Together, these directions move beyond early-cycle evaluation to a sustained research programme capable of producing stronger theory-building and evidence on postgraduate computing education at scale.

Acknowledgements

This work has been produced with the financial support of the European Union within the framework of "Digital4Business: Master's Programme focused on the Practical Application of Advanced Digital Skills within European Companies" (https://www.digital4business.eu), a project funded under the DIGITAL Europe Programme (Call: DIGITAL-2021-SKILLS-01; Project ID: 101084013) for the period December 2022 to November 2026.

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The author is the main coordinator contact for the Digital4Business project.

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