

MODULAR, ADAPTIVE CURRICULUM DESIGN FOR RAPIDLY EVOLVING DIGITAL DISCIPLINES: AN INTERDISCIPLINARY INFORMATICS AND DESIGN APPROACH

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Abstract

This paper presents the design and implementation of a practice-focused curriculum for a novel *Informatics and Design* degree program, addressing the need for interdisciplinarity, adaptability to technological change, and employability in higher education. Fully implemented in regular teaching, the curriculum is centered on project-based learning (PBL), with large-scale team projects serving as the primary learning environment from the very first semester. Curricular coherence and agility are achieved through a modular architecture consisting of foundational START modules, project-aligned intensive PRIMER blocks, flexible Learning Units, and a structured reflection layer. This framework provides targeted competencies within the project workflow while connecting practical application with critical reflection on ecological, social, and economic sustainability. The paper presents a transferable model demonstrating how modular, project-based structures can substantially enhance interdisciplinary collaboration and practical relevance in contemporary higher education.

Keywords: Curriculum design, project-based learning, practice-oriented pedagogy, modular curriculum, flexible learning units.

1. Introduction and motivation

In the context of Computer Science (CS) degree programs, *Media Informatics* historically served as a recognized pathway to integrate media technology, interface design and development, and Human-Computer Interaction. Recently, however, severe structural challenges have necessitated a fundamental curricular overhaul: (1) rapid technological advancements, such as AI-driven systems and extended reality, have completely altered the tools and contexts of digital product development (Naseer et al., 2025); (2) industry competency requirements have shifted toward integrative profiles that demand a seamless merge of technical depth with conceptual creativity (Smith & Baik, 2021); (3) societal expectations for sustainable and responsible technology design have intensified (Marouli et al., 2018); and (4) traditional, rigid modular teaching formats have proven insufficient to effectively foster modern research-oriented and project-based competencies, particularly those associated with the so-called 4C Model of Learning – critical thinking, creativity, communication, and collaboration – which are increasingly regarded as essential competencies in contemporary higher education (Afdal & Damşa, 2018; Gros et al., 2020; Thornhill-Miller et al., 2023).

Supported by the *Curriculum 4.0.nrw* funding line and the *Digitale Hochschule NRW*, the project “Media Informatics – Quo Vadis?” initiated a comprehensive transformation of the program's structure and pedagogy. Rather than incrementally adapting individual courses, the objective was a holistic redesign. Informed by systematic needs assessments with stakeholders, the resulting *Informatics and Design* curriculum is built on three core pillars: project-based learning, modular agility, and embedded sustainability.

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2. Theoretical and conceptual framework

Project-Based Learning (PBL) forms the pedagogical core of the curriculum, shifting the focus from passive content transmission to active knowledge construction via authentic, real-world problem-solving (Amiri, 2025; Guo et al., 2020). PBL organizes higher education around complex challenges requiring interdisciplinary thinking, iterative design, and critical reflection, thereby closely aligning instructional strategies and assessments with practical outcomes (Mutanga, 2024; Salwah et al., 2025; Zhang & Ma, 2023).

To support this active approach, a modular curriculum structure provides the agility needed to respond dynamically to emerging technologies (Brown, 2019). Incorporating micro-modules and just-in-time learning formats delivers targeted knowledge exactly when it is required in a project's lifecycle (Monib, Qazi, & Apong, 2025; Morrissey, Willison, & Hassan Ashkanani, 2026). This alignment improves immediate knowledge transfer, increases epistemic diversity, and heightens the curriculum's responsiveness to change.

Furthermore, sustainability is positioned as an overarching design principle rather than a supplementary topic. Students are systematically encouraged to evaluate the ecological, social, and economic consequences of their technological solutions throughout their coursework (Marouli et al., 2018).

3. Program design and didactic innovations

The program (see Figure 1) establishes a clear disciplinary profile rooted in foundational CS modules while simultaneously introducing technological flexibility through research-oriented PBL (Chen, Xue, & Wang, 2026). From the first semester via the START project module, through to a comprehensive two-semester major project in semesters four and five, students are engaged in continuous analysis, design, implementation, and evaluation.

To eliminate redundancies and enhance efficiency, the curriculum operates on a streamlined framework of didactic innovations:

- **START Modules:** Three integrated courses—START Project, START Computer Science, and START Design—provide a cohesive introduction, establishing a shared baseline for students with heterogeneous prior knowledge and fostering interdisciplinary thinking early on.
- **The PRIMER Concept:** Each subsequent project semester begins with a two-week intensive PRIMER block module. This guarantees a shared methodological and technical foundation tailored specifically to the upcoming project context, drastically improving workflow efficiency during the implementation phase.
- **Flexible Learning Units:** Operating as compact 3-ECTS electives, these units run in parallel to projects or as block courses. Selected from a frequently updated portfolio of roughly 40 units, they allow for rapid integration of novel technologies and active involvement of external industry experts (Monib, Qazi, & Apong, 2025).
- **Structured Reflection:** Dedicated reflection modules (e.g., "Informatics and Design in Culture and Society") ensure systematic inquiry into the cultural and sustainable impacts of digital design while actively supporting students' career competencies and employability.

Figure 1. Study plan for the Bachelor's degree program in Informatics and Design, according to the examination regulations 2023. Source: Own representation. (dated July 16, 2025).

Semester 1	Semester 2	Semester 3	Semester 4	Semester 5	Semester 6
Logic and Discrete Structures	Algorithms and Data Structures	Database Systems	Major Project Designing Sustainable Futures	Major Project Building Sustainable Futures	Practical Phase
Introduction to Programming	Object-Oriented Programming	Software Engineering	Primer	Primer	
Mathematical Foundations of Computer Science	Statistics and Linear Algebra	Human-Computer Interaction	Learning Unit	Learning Unit	Bachelor's Thesis
			Learning Unit	Learning Unit	
START Project	START Design	Extended Reality	Learning Unit	Learning Unit	
			Professional Skills		
START Computer Science	Technical English	Cross-Platform-Development	ID in Culture and Society	Community and General Studies	Bachelor's Colloquium

Finally, team teaching serves as a structural principle (Benjamin, 2000; Frelin, Grannäs, & Mörck Riekk, 2025). CS and Design professors jointly supervise projects, mirroring the cross-functional collaboration typical in modern professional practice (Gast, Schildkamp, & Van Der Veen, 2017). This ensures technical feasibility, aesthetics, and societal implications are negotiated concurrently within the same learning environment, thereby strengthening the research-teaching nexus (Ali & Abbas, 2019; Valle et al., 2025).

4. Initial results and discussion (winter semester 2025/26)

The first cohort of the program exceeded enrollment targets, indicating strong demand for its unique interdisciplinary profile. Preliminary survey feedback highlights high student motivation driven by the project-based entry phase, close mentoring, and the societal relevance of the integrated sustainability themes (Costa & Reis, 2025; Lindblom, 2019). While students reported a comparatively high workload due to continuous project engagement—a factor designated for future evaluation—the overall response has been overwhelmingly positive.

The redesign demonstrates that comprehensive curricular transformation is achievable when foundational stability (via the CS core) is carefully balanced with agile adaptability (via Learning Units and dynamic PBL topics). Rather than treating sustainability, interdisciplinary collaboration, and research orientation as separate components, they have been successfully and structurally interwoven. Future research will focus on analyzing long-term competency development, tracking dropout rates, and examining graduate employment outcomes compared to the legacy curriculum.

5. Conclusion

With the introduction of *Informatics and Design*, a forward-looking transformation of the former Media Informatics program has been successfully realized. Positive accreditation outcomes, robust enrollment, and encouraging student feedback confirm the strategic direction. The project serves as a highly transferable model for designing a degree program that is technologically adaptable, didactically innovative, socially responsible, and structurally future-proof.

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