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Embedding AI Competence into the Curriculum: The ADM-AI Model for European Higher Education

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Abstract:

Artificial intelligence is reshaping disciplinary practices and academic work, moving higher education beyond technical adoption towards human–AI collaboration as a core graduate capability. This raises a central challenge: how can AI-related human competences be systematically integrated into teaching and learning in ways that foster future-ready skills, while aligning pedagogical transformation with evolving teaching roles and institutional governance?

This paper introduces the Agile Curriculum Development Model (ADM-AI), a governance-compatible framework for systematically integrating AI-related human competences into higher education programmes. Its core contribution is to address the implementation gap between AI competence frameworks and programme-level curriculum transformation under formal higher education governance conditions. The model combines competence clarification, constructive alignment, curriculum mapping, and iterative implementation cycles, enabling continuous curriculum transformation within Bologna-type systems. AIComp serves as a conceptual starting point, providing an empirically grounded competence framework that defines AI competence as a multidimensional capacity for reflective, ethical, and collaborative engagement with AI. The model conceptualises curriculum transformation as a multi-level process linking institutional strategy, programme design, and pedagogical practice.

AI competences are enacted in situated learning environments where learners engage with AI systems as partners in inquiry, problem-solving, and knowledge construction, accompanied by a shift in academic roles towards learning design and facilitation. The model enables embedded, iterative innovation and positions implementation as institutional learning, offering a scalable approach to curriculum transformation in AI-mediated higher education.

Keywords: curriculum development, AI competence model, framework, future skills, agile integration, governance

Introduction

Artificial intelligence is transforming disciplinary practices and academic work, shifting higher education beyond technological adoption towards human–AI collaboration as a core dimension of learning and teaching (Ehlers & Lindner, 2024; Zawacki-Richter et al., 2019). This transformation requires institutions to move beyond adding isolated AI content and instead rethink how curricula, pedagogy, and organisational structures enable learners to act critically, responsibly, and collaboratively with AI (Ehlers, 2026). The challenge, however, is not only pedagogical but curricular and organisational: higher education institutions must determine how such competences can be embedded systematically across programmes rather than addressed through isolated educational responses.

At the same time, European higher education operates within the structural logic of the Bologna Process, which emphasises formal degree structures, comparability, quality assurance, and accredited programme architectures (European Association for Quality Assurance in Higher Education (ENQA) et al., 2015; European Ministers of Education, 1999). This creates a persistent tension between the need for rapid innovation and institutional regulation. Existing approaches often address AI through standalone modules, specialised programmes, or isolated teaching interventions, while systematic programme-wide integration remains

underdeveloped. In particular, existing AI competence frameworks define relevant target profiles, but only rarely provide an implementation logic for curriculum transformation under the governance conditions of formally regulated higher education (Ehlers & Lindner, 2024).

This paper addresses this gap by arguing that the central challenge of AI-related curriculum transformation is not merely to define relevant competences, but to translate them into programme architectures that are pedagogically coherent, institutionally feasible, and compatible with formal governance requirements. In response, it introduces the Agile Curriculum Development Model for AI Competences (ADM-AI), a four-phase framework for the iterative, programme-level integration of AI-related human competences within existing higher education structures. Rather than proposing disruptive reform, the model enables embedded curriculum innovation below the accreditation threshold and thereby offers an implementation logic for Bologna-type systems (Ehlers & Mann, 2026).

Methodological Approach

This study adopts a conceptual research design based on an integrative literature review and theory-driven model construction. Relevant literature was identified across major academic databases (Scopus, Web of Science, ERIC, Google Scholar), focusing on four domains: curriculum development in higher education, agile and iterative design approaches, educational design research and technology integration, and competence-based education with AI competence frameworks.

The analysis followed a thematic synthesis approach. Across the selected bodies of literature, recurring design principles, process logics, and governance constraints were identified, compared, and analytically condensed. These elements were then translated into a Bologna-compatible process model consisting of four phases and corresponding design artefacts, including competence profiles, learning objectives, curriculum maps, and implementation cycles. The aim was not to derive a model from a single theoretical tradition, but to construct a coherent framework at the intersection of competence orientation, constructive alignment, pedagogical design, and iterative implementation. As a conceptual contribution, the paper does not provide empirical validation; rather, it offers a theoretically grounded model to guide future implementation and research.

Conceptual Foundations

The proposed model builds on five complementary theoretical perspectives that together inform curriculum transformation in AI-mediated higher education.

First, curriculum theory within Bologna governance highlights the structural conditions of programme development, characterised by modularisation, outcome orientation, and accreditation-based quality assurance. These conditions stabilise programme coherence, but also constrain rapid structural change, making innovation most feasible through embedded redesign within existing modules rather than programme disruption (Biggs & Tang, 2011; Seidl & Vonhof, 2017). From this perspective, AI competence integration must be conceived at the level of programme coherence rather than as isolated interventions, while constructive alignment functions as the central quality logic linking competences, learning outcomes, teaching formats, and assessment.

Second, agile development theory offers a process model for innovation under conditions of uncertainty. Originating in software development (Beck et al., 2001) agile approaches have been adapted to regulated public-sector contexts, emphasising iterative development, stakeholder participation, and continuous feedback within governance constraints (Janssen & van der Voort, 2020; Mergel et al., 2021) In higher education, this translates into curriculum development as a form of governed iteration: reform proceeds through small-scale, time-boxed cycles, pilots precede scaling, stakeholder participation is structurally embedded, and feedback loops are institutionalised as part of evidence-based refinement (Härer et al., 2025). Accordingly, an explicit implementation cycle becomes a core design element of agile curriculum transformation rather than a supplementary feature.

Third, educational design research (EDR/DBR) conceptualises curriculum innovation as iterative cycles of design, implementation, evaluation, and redesign (McKenney & Reeves, 2018). This perspective is particularly relevant in AI-related contexts, where evolving technologies reshape disciplinary knowledge practices and require continuous adaptation (Zawacki-Richter et al., 2019). From this perspective, curriculum innovation should be treated as a process of iterative design knowledge production rather than mere implementation, with explicit evidence capture and structured reflection built into the design itself. It further supports combining concept formation and alignment with a bounded enactment window and retrospective learning

loop, thereby justifying a four-phase logic in which design architecture and time-boxed implementation are systematically connected.

Fourth, technology integration and instructional design frameworks explain how AI becomes educational practice within disciplinary teaching. TPACK conceptualises technology integration as the intersection of disciplinary, pedagogical, and technological knowledge, underscoring that AI competence must be embedded in subject-specific teaching rather than reduced to generic tool use (Koehler et al., 2013; Mishra & Koehler, 2006; Schmidt et al., 2009). SAMR adds a further lens by distinguishing between enhancement and transformation, thereby drawing attention to the depth of integration and the extent to which AI reshapes epistemic tasks rather than merely substituting existing practices (Hamilton et al., 2016; Puentedura, 2014). Complementing these perspectives, agile instructional design models such as SAM provide a rationale for rapid prototyping and stakeholder-informed revision under conditions of uncertainty (Allen & Sites, 2012). From this perspective, format selection must be framed as discipline–pedagogy–technology integration, curriculum design must make explicit decisions about integration depth, and sprint-based prototyping becomes a theoretically grounded strategy for iterative instructional development.

Fifth, competence-based education and AI competence frameworks provide the normative orientation for curriculum development. Competence is understood as a context-dependent disposition for effective action extending beyond technical skills (OECD, 2018; Weinert, 2001), to include ethical judgement, critical reflection, human–AI collaboration, and societal responsibility (Long & Magerko, 2020; Zawacki-Richter et al., 2019). Frameworks such as AIComp offer empirically grounded structures for defining and mapping these competences within higher education programmes (Ehlers & Lindner, 2024). From this perspective, competence frameworks provide the substantive foundation for curriculum transformation: they define relevant target competences, enable systematic mapping across programmes, and support constructive alignment by linking competence goals to learning outcomes, teaching formats, and assessment.

A critical counterpoint to this, demonstrating that AI in higher education is often constructed through a "imperative response" discourse in which institutions are described as needing to adapt to technological change, and a "altering authority" discourse in which agency and authority pass back and forth between teachers, students, institutions, AI systems, data infrastructures and commercial actors (Bearman et al., 2023). For ADM-AI, this means that the integration of AI competence must not be understood as neutral technology adoption but as a governance-sensitive curriculum process that makes explicit questions of accountability, pedagogical judgement, institutional power and stakeholder agency.

Across these perspectives, curriculum transformation is conceptualised as a multi-level process linking institutional governance, programme design, and pedagogical practice. This synthesis informs the ADM-AI model, which integrates competence orientation, constructive alignment, technology-mediated pedagogical design, and iterative implementation into a coherent framework for embedding human–AI collaboration at the level of programme architecture, teaching practice, and institutional governance.

AI Competence Framework (AIComp)

The AIComp framework (AI Competences) (Fig. 1) provides an empirically grounded competence architecture for understanding AI-related capabilities in higher education. Developed by the NextEducation Research Group at DHBW Karlsruhe and based on a large-scale study with over 1,600 professionals in Baden-Württemberg, it identifies key competences for acting in AI-permeated environments (Ehlers & Lindner, 2024). Conceptually, AIComp is embedded in the broader Future Skills framework (Ehlers, 2020), which defines competences as context-dependent dispositions for acting effectively in complex and dynamic situations. AI competence is therefore understood not only as technical proficiency, but as a multidimensional construct that includes reflective, ethical, creative, and collaborative capacities for engaging with AI.

The framework distinguishes three interrelated dimensions: (1) self-related competences, including reflective AI literacy and ethical awareness; (2) competences for working and designing with AI, such as problem-solving and innovation; and (3) competences for shaping social and organisational contexts, including collaboration and communication. These dimensions are operationalised through twelve competence fields and specified into measurable learning outcomes, enabling systematic competence mapping, curriculum integration, and constructive alignment across learning outcomes, teaching formats, and assessment (Ehlers & Lindner, 2024).

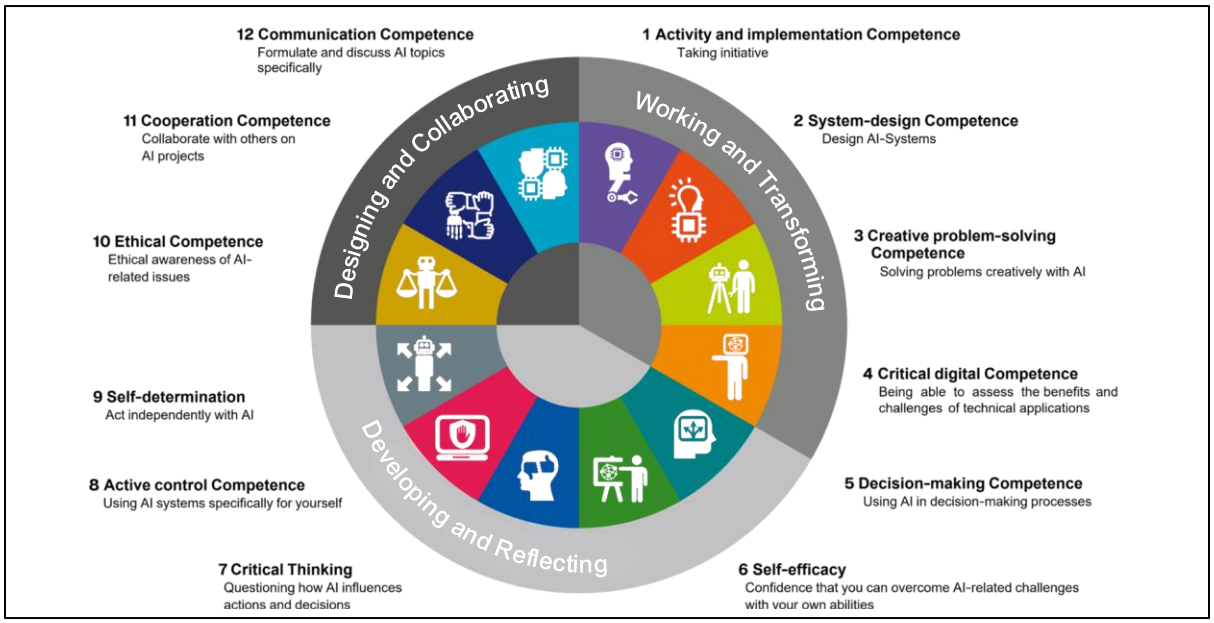


Figure 1: Competence Structure Model AIComp (Ehlers & Lindner, 2024)

Agile Curriculum Development Model (ADM-AI)

The ADM-AI model is a four-phase process framework for the programme-level integration of AI-related competences into higher education curricula through an iterative and governance-compatible approach (Fig. 2). It translates the need for human–AI collaboration into a structured development process that connects institutional strategy, programme design, and teaching practice. The model follows a clear progression logic: it begins by identifying relevant AI competences within a disciplinary context, translates these into pedagogically meaningful learning objectives and formats, embeds them into the curriculum structure, and implements and refines them through iterative cycles. Rather than promoting disruptive reform, the model enables incremental, evidence-based change within existing programme structures and thereby addresses the implementation gap between competence frameworks and curriculum practice (Ehlers & Mann, 2026).

Phase 1: Clarifying AI Competence Needs

Phase 1 establishes the conceptual and strategic foundation for curriculum development by defining which AI-related competences are relevant for a given study programme and why. It ensures that curriculum transformation is grounded in a clear understanding of disciplinary change and not driven by technological trends alone (Ehlers & Mann, 2026).

Step 1: Scoping and Clarifying the Initial Situation

Scoping and Clarifying the Initial Situation examines how artificial intelligence is transforming the discipline, research methods, professional practice, and societal expectations. It also identifies shifts in how knowledge is generated, validated, and applied. The aim is to create a shared understanding of the programme's transformation context. The result is a scoping statement that defines the AI-related development horizon and structural conditions.

Step 2: Collecting and Clustering Relevant Competencies

Collecting and Clustering Relevant Competencies builds on this analysis by identifying relevant AI-related competences. These may be derived from existing competence frameworks such as AIComp, international policy frameworks, or discipline-specific models. However, rather than adopting these frameworks uncritically, competences are examined and adapted to fit the specific context. They are subsequently grouped into thematic clusters, which reduces conceptual complexity and supports semantic alignment among stakeholders. This step ensures that competence definitions are both theoretically grounded and contextually meaningful.

Step 3: Positioning and Prioritising Competences

Positioning and Prioritising Competences introduces a strategic selection process. Competences are assessed by their future relevance for the discipline and learners' current competence levels. This structured gap analysis identifies competences that are both highly relevant and insufficiently developed. The result is a prioritised set of key competences for curriculum design.

Step 4: Subject-Specific Contextualisation and Documentation

Subject-Specific Contextualisation and Documentation translates prioritised competences into discipline-specific learning outcomes aligned with academic standards, programme structures, and accreditation requirements. The result is a clearly defined competence profile that guides the following phases.

Phase 2: Determining Learning Objectives and Teaching Formats

Phase 2 translates identified competences into pedagogically actionable forms by specifying how they are developed and assessed. It ensures coherence between competence goals, instructional design, and assessment strategies (Ehlers & Mann, 2026).

Step 1: Deriving and Documenting Learning Objectives

This step translates competences into observable and assessable learning outcomes. Learning objectives define the concrete performances students should demonstrate, clarify expected outcomes, and provide the basis for constructive alignment between teaching and assessment.

Step 2: Developing and Interlinking Teaching Formats

In this step, learning environments are designed in which students actively develop the targeted competences. It emphasises experiential, inquiry-based, and practice-oriented learning, with AI understood as a partner in processes such as problem-solving, creative design, and reflection. Suitable formats include projects, case studies, simulations, interdisciplinary collaboration, or research-based tasks. The outcome is a coherent set of aligned learning objectives and teaching formats for curriculum integration.

Phase 3: Building the Curriculum

Phase 3 integrates competences, learning objectives, and teaching formats into the programme structure across modules and over time. It shifts the focus from individual courses to the curriculum as a coherent whole. Curriculum mapping links competences, modules, teaching formats, and assessment and supports progression from foundational knowledge to advanced application and reflection. A coherence and governance check identifies gaps, redundancies, and inconsistencies and ensures alignment with accreditation requirements, examination regulations, and programme structures. The result is a coherent and feasible curriculum design (Ehlers & Mann, 2026).

Phase 4: The 90-Day Implementation Cycle

Phase 4 operationalises curriculum transformation through iterative 90-day cycles. These cycles generate pedagogical evidence while enabling responsive, low-risk adjustment in regulated programme environments. The model uses pilots to test new curriculum elements in selected modules or learning settings under defined responsibilities and institutional conditions. Student feedback, learning artefacts, and teacher reflections provide evidence on competence development. This evidence informs reflection and refinement, so curriculum elements are revised, scaled, or discontinued. Repeated cycles support institutional learning and continuous curriculum development (Ehlers & Mann, 2026).

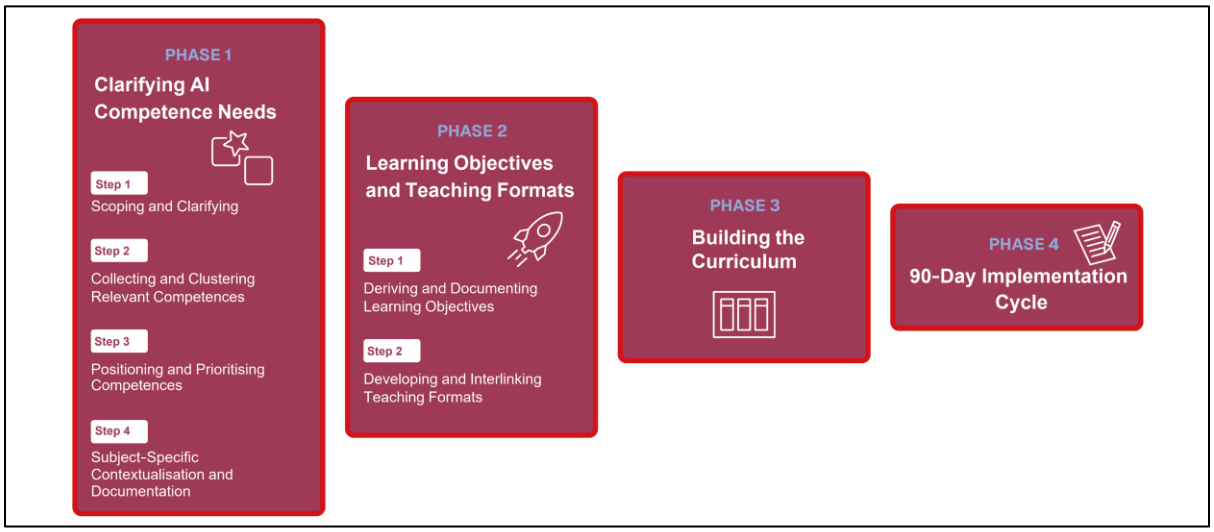


Figure 2: ADM-AI Framework for agile curriculum development (Ehlers & Mann, 2026)

Six Principles

The four phases of ADM-AI are guided by six cross-cutting design principles that support pedagogically meaningful and institutionally feasible curriculum transformation. They translate agile values such as iteration, stakeholder orientation, and continuous feedback into governance-compatible rules for programme innovation within Bologna structures. In doing so, they connect agile thinking with the practical requirements of study programme development in higher education and provide operational orientation for curriculum change under regulated programme conditions (Ehlers & Mann, 2026).

1. **Integrative:** The first principle emphasizes that AI and future competences should be embedded in existing modules, learning objectives, and assessments rather than added separately. This supports gradual curriculum innovation and ensures these competences are part of the programme as a whole.

2. **Participatory:** The second principle stresses participatory co-creation across all phases of programme development. Students, faculty, administrators, and, where relevant, external partners are involved from planning to implementation and evaluation. This reflects the agile focus on collaboration and continuous feedback while also strengthening legitimacy and feasibility in regulated higher education contexts.

3. **Iterative:** The third principle highlights iterative, sprint-based development cycles. Curriculum innovation proceeds in defined phases, such as 90-day pilots, followed by structured reflection and decisions. This allows programmes to improve step by step while also rethinking underlying assumptions, not just specific practices.

4. **Experimental:** The fourth principle emphasizes experimental, small-scale adjustments within existing module structures. This allows programmes to test innovations in a manageable way without requiring full re-accreditation. It reflects an agile approach to change through bounded experimentation rather than major disruption.

5. **Visible:** The fifth principle focuses on visibility through clear evidence of competence development. Learning outcomes are made explicit and documentable, for example through artefacts, badges, microcredentials, or transcript entries. This supports agile decision-making by providing observable results that inform further development and organisational learning.

6. **Holistic:** The sixth principle views curriculum development as a systemic process that connects disciplinary requirements, institutional strategy, accreditation rules, and societal needs. It extends agile thinking beyond individual projects to ensure that innovation stays coherent, strategically aligned, and future-oriented.

Conclusion

The ADM-AI model offers a structured, governance-compatible approach to integrating AI-related human competences into higher education curricula. Its central contribution lies in translating competence frameworks into an implementation model for programme-level curriculum transformation under Bologna-type governance conditions. By linking competence orientation, constructive alignment, curriculum mapping, and iterative implementation, the model provides a theoretically grounded basis for embedded and scalable curriculum innovation. At the same time, the present paper is conceptual in nature. Future research should therefore examine how ADM-AI performs across disciplinary contexts, institutional settings, and different levels of curriculum change.

As a conceptual model, ADM-AI does not yet provide empirical evidence of effectiveness across institutional contexts. In addition, its strongest fit is likely to be in modularised and formally regulated higher education systems, particularly those shaped by Bologna-type governance structures.

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References

Allen, M., & Sites, R. (2012). Leaving Addie for SAM: An Agile Model for Developing the Best Learning Experiences. Association for Talent Development.

Bearman, M., Ryan, J., & Ajjawi, R. (2023). Discourses of artificial intelligence in higher education: A critical literature review. Higher Education, 86(2), 369–385. https://doi.org/10.1007/s10734-022-00937-2

Beck, K., Beedle, M., van Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., & Grenning, J. (2001). Manifesto for Agile Software Development. Zwölf Prinzipien Agiler Softwareentwicklung. https://agilemanifesto.org/

Biggs, J. B., & Tang, C. S. (with Society for Research into Higher Education). (2011). Teaching for quality learning at university: What the student does (4th edition). McGraw-Hill/Society for Research into Higher Education/Open University Press.

Ehlers, U.-D. (2020). Future Skills: Lernen der Zukunft - Hochschule der Zukunft. Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-29297-3

Ehlers, U.-D. (2026, March 11). NextBlog—Unveiling the Truth of AI and Education. NextEducation. Unveiling the Truth of AI and Education From Red Pill to Red Will. https://next-education.org/de/team-blog/ne-teamblog/unveiling-the-truth-of-ai-and-education-from-red-pill-to-red-will/2026-03-11/41/

Ehlers, U.-D., & Lindner, M. (2024). DHBW AI Transfer Congress 2024 Proceedings: AICOMP – An investigation into future skills for a world shaped through AI. (DHBW AI Transfer Congress 2024 Proceedings), 63–71. https://doi.org/10.5334/uproc.91

Ehlers, U.-D., & Mann, J. M. (2026, January). Playbook Agile Studiengangentwicklung. Duale Hochschule Baden-Württemberg. https://ai-comp.org/downloads/PlaybookAgileStudiengangentwicklung1.1.pdf

European Association for Quality Assurance in Higher Education (ENQA), European Students' Union (ESU), European University Association (EUA), & European Association of Institutions in Higher Education (EURASHE). (2015). Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG). Standards and Guidelines for Quality Assurance in the European Higher Education Area. https://doi.org/978-9-08-168672-3

European Ministers of Education. (1999, June 19). European Higher Education Area and Bologna Process. The Bologna Declaration of 19 June 1999. https://ehea.info/page-ministerial-conference-bologna-1999

Hamilton, E. R., Rosenberg, J. M., & Akcaoglu, M. (2016). The Substitution Augmentation Modification Redefinition (SAMR) Model: A Critical Review and Suggestions for its Use. TechTrends, 60(5), 433–441. https://doi.org/10.1007/s11528-016-0091-y

Härer, F., Herzwurm, G., & Schmidt, R. (2025). Agilität in der Studiengangsentwicklung an deutschen Hochschulorganisationen – Eine Bestandsaufnahme. Gruppe. Interaktion. Organisation. Zeitschrift für Angewandte Organisationspsychologie (GIO), 56(1), 185–195. https://doi.org/10.1007/s11612-025-00799-z

Janssen, M., & van der Voort, H. (2020). Agile and adaptive governance in crisis response: Lessons from the COVID-19 pandemic. International Journal of Information Management, Impact of COVID-19 Pandemic on Information Management Research and Practice: Editorial Perspectives, 55, 102180. https://doi.org/10.1016/j.ijinfomgt.2020.102180

Koehler, M. J., Mishra, P., & Cain, W. (2013). What is Technological Pedagogical Content Knowledge (TPACK)? Journal of Education, 193(3), 13–19. https://doi.org/10.1177/002205741319300303

Long, D., & Magerko, B. (2020). What is AI Literacy? Competencies and Design Considerations. Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems, CHI '20, 1–16. https://doi.org/10.1145/3313831.3376727

McKenney, S., & Reeves, T. (2018). Conducting Educational Design Research (2nd Edition).

Mergel, I., Ganapati, S., & Whitford, A. B. (2021). Agile: A New Way of Governing. Public Administration Review, 81(1), 161–165. https://doi.org/10.1111/puar.13202

Mishra, P., & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. Teachers College Record, 108(6), 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

OECD. (2018). The Future of Education and Skills: Education 2030 (OECD Education Policy Perspectives No. 98; OECD Education Policy Perspectives, Vol. 98). https://doi.org/10.1787/54ac7020-en

Puentedura, R. R. (2014). SAMR: A Model for Educational Technology Integration. Harvard Unitersity Press.

Schmidt, D. A., Baran, E., Thompson, A. D., Mishra, P., Koehler, M. J., & Shin, T. S. (2009). Technological Pedagogical Content Knowledge (TPACK): The Development and Validation of an Assessment Instrument for Preservice Teachers. Journal of Research on Technology in Education, 42(2), 123–149. https://doi.org/10.1080/15391523.2009.10782544

Seidl, P. D. T., & Vonhof, C. (2017, July 21). Agile Prinzipien – Was kann die Studiengangsentwicklung davon lernen? (3). https://hochschulforumdigitalisierung.de/agile-prinzipien-was-kann-die-studiengangsentwicklung-davon-lernen/

Weinert, F. E. (2001). Concept of competence: A conceptual clarification.. Seattle: Hogrefe & Huber.

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education – where are the educators? International Journal of Educational Technology in Higher Education, 16(1), 39. https://doi.org/10.1186/s41239-019-0171-0