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DIGITAL SKILLS FOLLOWED BY FUTURE SKILLS? RECENT RESEARCH INSIGHTS AND IMPACT ON UNIVERSITY DEVELOPMENT

Jörn Allmang [1], Ulf-Daniel Ehlers [1], Laura Eigbrecht [1], Gerhard Götz [1], Myriam Hamich [1] and Felix Weschenfelder [2]*

[1] Baden-Wuerttemberg Cooperative State University (DHBW) and Institute for Higher Education and Educational Research (IHB) of the Baden-Wuerttemberg Cooperative State University (DHBW), Germany

[2] Baden-Wuerttemberg Cooperative State University (DHBW), Institute for Higher Education and Educational Research (IHB) of the Baden-Wuerttemberg Cooperative State University (DHBW) and Heidelberg University of Education, Germany

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Abstract
This paper addresses the challenges of societal, technological, and ecological transformations from an integrative, practice-informed perspective that explicitly connects Future Skills, digital literacy, and computer science competences with institutional development in higher education and programme design. The contribution synthesises insights from interdisciplinary case studies that were condensed, presented, and critically discussed in a scholarly symposium format. Each intervention was implemented within design-based research setting. The findings suggest that implementations are more successful when they allow flexibility and supervision and embed students' reflection.

1 Introduction

Over the past decade, higher education institutions have been confronted with profound societal, technological, and ecological transformations that challenge established assumptions about academic learning and graduate preparedness. Digitalisation, artificial intelligence, sustainability transitions, and accelerating innovation cycles increasingly confront graduates with uncertainty, complexity, and rapid change. Universities can therefore no longer focus primarily on transmitting disciplinary knowledge; they must also enable students to act competently, responsibly, and self-

* Corresponding author
E-mail address: Gerhard.Goetz@mosbach.dhbw.de

organised in open-ended contexts. This shift has intensified the relevance of Future Skills in research, policy debates, and institutional development (Ehlers, 2020; OECD, 2019).

This challenge is particularly visible in dual higher education. Dual study programmes are designed to connect academic and workplace learning, yet the degree and quality of integration between these learning sites often vary considerably and may leave students with a substantial “transfer burden” in creating coherence themselves (Mordhorst & Jenert, 2023). At the same time, this very structure makes dual programmes a highly relevant arena for Future Skills development: they offer authentic, iterative experiences across contexts, but they also require carefully designed pedagogical and curricular arrangements to transform experience into competence development.

Against this background, the relationship between Future Skills, digital literacy, and computer science competences requires greater analytical clarity. In this paper, Future Skills are understood as broader action-oriented competences that enable self-directed, reflective, collaborative, and responsible action under conditions of uncertainty and emergence (Ehlers, 2020). Digital literacy refers to the reflective, critical, and purposeful use of digital environments, information, and tools in learning and professional contexts. Computer science competences, in turn, denote more foundational technical-conceptual understandings such as algorithmic logic, data-related thinking, and knowledge of digital systems. The three domains are closely related, but they are not identical: Future Skills constitute the broader competence horizon, digital literacy functions as a transversal enabling domain, and computer science competences represent a more specific foundational component within technology-related competence development.

This paper assumes that these three domains should not be treated separately if higher education aims to respond adequately to contemporary transformation pressures. Rather, they need to be analysed in relation to one another and in relation to university development and programme design. This is especially important because this integrative perspective often recedes behind isolated curricular initiatives or stand-alone support offers. To address this gap, the paper brings together three interdisciplinary mini case studies that examine competence development from different but connected angles: (1) curriculum-integrated Future Skills development in dual higher education, (2) digital literacy as a transversal enabler of Future Skills, and (3) foundational computer science competences as a component of data- and technology-related Future Skills. Taken together, the cases allow not only individual description but also analytical comparison with regard to common goals, different mechanisms, and transferable design principles.

Methodologically, the paper therefore follows an interdisciplinary multiple case study approach with a comparative perspective. The individual cases differ in context, target group, intervention format, and empirical basis; these methodological differences are addressed within the respective case descriptions because they are integral to understanding how competence development is supported in each setting. At the same time, the cases are linked by a shared analytical lens: all examine how competence-oriented learning arrangements can be designed to support future-oriented learning in higher education. The purpose of the cross-case perspective is not to collapse differences, but to make visible where the cases converge, where they diverge, and which insights may be transferable across contexts. In doing so, the paper distinguishes between empirical data, theory-informed design rationales, and reflective implementation insights, and uses these different forms of material for distinct analytical purposes. Guided by this integrative perspective, the paper pursues the following research questions:

1. How can Future Skills be meaningfully integrated into higher education curricula across diverse disciplinary and institutional contexts, especially in dual study programmes?
2. What roles do digital literacy and computer science competences play as enabling or constitutive elements of Future Skills development?
3. Which pedagogical design principles and learning environments support sustainable competence development across the three domains?

This section offers a structural overview by outlining the subsequent chapters, their focus and their relation to the previously introduced research questions. Chapter 2 introduces the methodological framing and the shared analytical lens used to relate the cases to one another. Chapters 3 to 5 present the three case studies which take a deliberately tiered analytical perspective on skills development in higher education. Chapter 3 examines the meta-level of future skills as an overarching orientation framework for learning and teaching requirements in the context of digital and social change, thereby addressing research question 1. Building on this perspective, chapter 4 explores digital literacy as a central component of this broader competence spectrum, while chapter 5 focuses on computer science and IT-related competences as more specialised forms. Both chapters contribute to addressing research question 2. Together, the case studies outline a conceptual development process from general future competences to domain-specific digital literacy to sound computer science competences. With regard to research question 3, a concluding synthesis summarises cross-case insights, identifies convergences and divergences, and discusses their implications for programme designs, institutional development, and the transferability of competence-oriented approaches in higher education.* The results for all three research questions are presented in chapter 6.1. Chapter 6.2 concludes with an outlook on future work.

2 Methodological Framing

2.1 Conceptual definition of Future Skills (analytical lens)

This study adopts a competence-theoretical understanding of Future Skills as action-oriented competences that enable individuals to deal with complex problems in highly emergent contexts in a self-organised manner (Ehlers, 2020). In this perspective, competences cannot be reduced to isolated skills; rather, they are dispositions to act that become visible in situated performance and develop over time through experience and reflection (Weinert, 2001; Ehlers, 2020).

To make this shared analytical lens explicit for the cases and the subsequent cross-case synthesis, Figure 1 is positioned in this section. It serves as a common reference frame for mapping the competence focus of each case, comparing how different interventions address competence development, and relating the cases across learning sites, formats, and didactic mechanisms. In this way, the figure does not merely illustrate the theoretical background, but provides the conceptual bridge between the individual case descriptions and the comparative discussion.

This conceptual positioning is deliberately integrative, but it does not treat Future Skills, digital literacy, and computer science competences as interchangeable concepts. The literature uses partially overlapping terms such as Future Skills, transversal competences, key competences, digital competences, digital literacy, AI literacy, and computer science competences, yet these approaches differ in their normative orientation, domain specificity, and underlying model of learning. While some emphasise employability and labour-market relevance, others foreground agency, sustainability, participation, or personal development.

Against this background, the paper assumes a layered relationship: Future Skills provide the broader educational horizon of self-organised, reflective, collaborative, and responsible action under conditions of uncertainty; digital literacy functions as a transversal enabling domain within this horizon; and computer science competences form a more specific foundation for understanding, evaluating, and shaping digital systems. This positioning addresses a central tension in the field: broad Future Skills frameworks require concrete pedagogical and disciplinary translation, while digital and computer science competence models risk remaining too narrow if detached from questions of agency, responsibility, reflection, and transformation.

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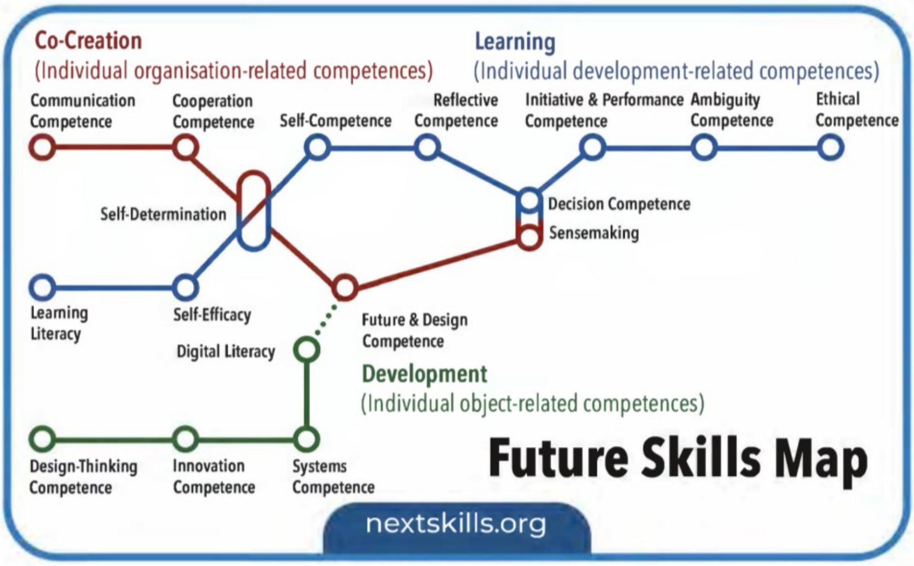

Figure 1. NextSkills Competence Framework

2.2 Research design: An interdisciplinary multiple case study approach

Methodologically, the paper follows an interdisciplinary multiple case study design, using three mini case studies as analytically comparable units. Case study research is particularly appropriate when complex educational phenomena are examined in context while preserving the richness of authentic settings (Stake, 1995; Yin, 2018; Merriam & Tisdell, 2016). The aim is not statistical generalisation, but analytical insight into how competence-oriented interventions are designed, embedded, and reflected upon in different higher education contexts.

The unit of analysis is the competence-oriented educational intervention within its institutional and pedagogical context. Each case is therefore treated not as a complete institutional case, but as a bounded intervention case: Case 1 focuses on a curriculum-integrated Future Skills programme in dual higher education; Case 2 focuses on a modular online course for digital literacy; and Case 3 focuses on a preparatory blended-learning course for foundational computer science competences. The cases are comparable because each addresses the design and implementation of learning arrangements intended to support future-oriented competence development in higher education. At the same time, they differ in disciplinary location, target group, implementation maturity, empirical basis, and degree of curricular integration.

This distinction is important because the paper combines empirical evidence, design rationale, and reflective documentation. Empirical data are understood as systematically collected materials such as survey results, Delphi findings, evaluation data, and participant feedback. Design rationales refer to the theory-informed reasons for selecting specific pedagogical formats, tools, or competence models. Reflective documentation comprises structured observations and lessons learned during development, implementation, and scholarly exchange. These three types of material are not treated as equivalent evidence. Rather, they serve different analytical functions: empirical data support claims about participants' perceptions, needs, or expert judgements; design rationales explain why particular interventions were constructed in a specific way; and reflective documentation helps interpret implementation conditions, limitations, and transferability.

The three cases are comparable because they address a shared problem space: the development of future-oriented competences in higher education. More specifically, they (1) focus on competences that go beyond narrow disciplinary knowledge, (2) operate at the interface between curricular structures and transversal support formats, (3) rely on students' active engagement and self-directed learning, and (4) require adaptation to specific institutional, disciplinary, and learner-related conditions. The cases are therefore not methodologically standardised, but systematically related through a common analytical lens. This allows the paper to preserve the specificity of each intervention while making cross-case patterns visible.

Due to the fact that the case studies are performed at different levels of development, their presentation differs to some extent within this work: While the Future Skills framework has been established for some time, the foundations of digital literacy and computer science competences have been adapted more recently to our university and therefore we present more detail on the research that informed their development. The cases were developed and refined through interdisciplinary scholarly collaboration in a symposium format, involving perspectives from educational science, competence research, computer science education, and higher education didactics. This process helped establish a shared analytical language while preserving domain-specific depth.

2.3 Relation to design-oriented educational research

Beyond descriptive case reporting, the study is informed by principles of Design-Based Research (DBR), as all three cases centre on interventions that were designed for authentic educational settings and iteratively developed through reflection and evidence. DBR is commonly described as linking theory-informed design with systematic inquiry in practice in order to generate context-sensitive design principles and explanatory insights (Design-Based Research Collective, 2003; Wang & Hannafin, 2005). In this paper, DBR serves less as a strict methodological protocol than as an orientation for relating intervention design, implementation, and learning-oriented refinement across cases.

2.4 Data sources, cross-case synthesis, and quality considerations

Across the cases, the empirical materials include, depending on the case, expert-based Delphi results, formative evaluation data from intervention implementations, design rationales, and reflective documentation from development processes. The cross-case analysis follows a comparative interpretative logic and focuses on three guiding dimensions: (1) common pedagogical design principles and learning mechanisms, (2) context-specific enabling conditions and barriers, and (3) the role of digital literacy and computer science competences in relation to broader Future Skills outcomes. This comparative perspective is intended to make convergences, divergences, and transferable insights across the three cases more explicit.

The cross-case synthesis was conducted in three analytical steps. First, each case was reconstructed individually with regard to its competence focus, intervention design, data basis, implementation context, and stated limitations. Second, the cases were compared along three guiding dimensions: (1) pedagogical design principles and learning mechanisms, (2) enabling conditions and barriers in the respective institutional and curricular contexts, and (3) the relationship between Future Skills, digital literacy, and computer science competences. Third, convergences and divergences were interpreted with regard to their transferability beyond the specific institutional setting.

The comparison therefore did not aim to identify one uniform model of competence development. Instead, it asked how different interventions make future-oriented competence development possible under different conditions. This comparative logic is particularly relevant because the three cases represent different levels of competence development: the first case addresses Future Skills as a broad institutional and curricular orientation; the second case focuses on digital literacy as a transversal enabling domain; and the third case examines foundational computer science competences as a more specific technical-conceptual component. The cross-case synthesis thus follows an interpretative and theory-informed logic rather than a purely aggregative one.

To enhance transparency, the analytical status of claims is differentiated throughout the paper. Claims based on empirical data are presented as findings from surveys, Delphi procedures, evaluations, or participant feedback. Claims based on design decisions are framed as design rationales or pedagogical assumptions. Claims based on implementation experience are presented as reflective insights and are discussed with regard to their limitations. This distinction strengthens the methodological robustness of the paper by clarifying what counts as data, what counts as theoretically informed design reasoning, and what counts as reflective interpretation. The credibility of the synthesis is supported through transparent case descriptions, triangulation across materials where available, and explicit articulation of limitations and scope (Yin, 2018; Merriam & Tisdell, 2016).

3 Case Study 1: Integrating Future Skills into the curriculum

3.1 Theoretical background and setting

Ongoing processes of societal transformation are not only changing societal and professional contexts, but also the structures and self-understanding of higher education institutions. Universities are therefore confronted with the task of actively shaping this transformation and enabling students to participate in it in a reflective and responsible way. From an educational-theoretical perspective, the aim is not merely to equip students with knowledge for foreseeable situations, but to support them in developing dispositions that allow them to act in open, uncertain and dynamically changing contexts, navigate complexity, collaborate effectively, and drive social change. In this context, the concept of so-called Future Skills is becoming extremely significant. These competences are often discussed in research and European policy debates as “transversal skills” (García-Álvarez et al., 2022) “sustainability competences” or “green skills” (Bianchi et al., 2022). Despite their different emphases, these approaches share a common objective: they seek to prepare students to engage constructively with future challenges and to remain capable of acting in, and shaping, situations characterised by uncertainty, ambiguity and transformative change (Ehlers, 2020). This calls for an updated understanding of learning environments that foster participation, learner agency and self-directed learning, and that understand students as active co-creators of their own educational processes as well as societal and technological change. Providing such learning opportunities for students is a challenge that universities must rise to.

3.2 Project [A]

The project [A] builds on the premise that dual study programmes provide a particularly favourable learning environment for iterative competence development, given their structured alternation between academic and workplace phases. The two-year programme, informed by prior conceptual work and evaluation studies conducted at the university, aims to strengthen the integration of theory and practice and to deepen students’ reflective engagement with Future Skills by fostering self-directed and reflective learning, grounded in their real-world experiences. Therefore, the project designs a curriculum-integrated, multi-stage Future Skills programme, consisting of various learning materials and didactic concepts. In addition, a peer-circle-based digital competence ePortfolio is implemented to extend competence development into a continuous reflective process, using the experiences students gain within their partner organisations. Before presenting the individual learning materials and instructional formats, we outline key design principles for learning environments that effectively support the development of Future Skills.

3.3 Learning theory background and didactic approach to the concept

In addition to the core idea of shifting from isolated learning episodes to a continuous reflection flow that fosters competence development over time, the project’s approach draws on a set of complementary learning-theoretical perspectives. Taken together, these elements can be understood as key prerequisites for competence development within our Future Skills approach, which conceptualises Future Skills as action competences and thus forms the conceptual and didactic foundation of the Future Skills programme.

Kolb’s (1984) experiential learning model describes learning as a four-stage cycle that helps students become more aware of their own learning processes. The learning cycle begins with concrete, personally relevant experiences, which are then subjected to self-reflection, analysed to identify patterns and insights. Finally, learners translate these insights into adapted action in practice; this modified action generates new experiences and thereby reinitiates the cycle. A second central learning-theoretical foundation for competence development that underpins the project [A] dual-learning approach is Donald Schön's (1983) concept of the reflective practitioner. Schön distinguishes between two forms of reflection: reflection-in-action, in which individuals reflect and make adjustments while performing an activity, and reflection-on-action, in which they review and analyse their actions subsequently. Students are encouraged to develop their Future Skills in a similar way: by making their implicit knowledge explicit, considering alternative courses of action in specific contexts, and formulating small, personal theories of action. External learning stimuli, particularly in the form of feedback, further enrich this reflective process. Yan and Boud (2022) highlight the importance of formative feedback for the competence development of students, arguing that feedback is most effective when it supports learners in monitoring, regulating and reorienting their own learning rather than merely evaluating learning outcomes (summative feedback). Accordingly, the concept also places a strong emphasis on peer learning processes and peer feedback during the workshops and throughout the semester to ensure external feedback on the competence development. Within this framework, the learning design is explicitly strengths-oriented and informed by positive psychology (Seligman & Csikszentmihalyi, 2000) as well as grounded in situated authentic learning settings (Mandl & Krause, 2001). Students are therefore encouraged to identify personally successful action situations and to analyse these experiences through the lens of the Future Skills competence structure model. Operationally, this Future Skills learning design aligns with Kovalcik’s (2019) four-step progression of competence development, which moves from the need to name and define Future Skills to building awareness and identifying personally meaningful competences, linking them to lived experience, and finally articulating and transferring them across different contexts.

3.4 Previous evaluation results of the Future Skills learning intervention

Findings from prior pilot implementations indicate that the Future Skills programme was rated as important and helpful by a large majority of participants and was met with high levels of student interest and acceptance, underscoring the relevance of the underlying pedagogical concept (Authors 1). In an evaluation of the first piloting of the Future Skills learning intervention, outcomes were assessed, using a standardised online questionnaire (n=744 students) that was distributed to students at the end of a Future Skills introductory workshops across different study programmes and faculties. The survey comprised 30 items and used a five-point Likert scale, included sociodemographic data, and captured four dimensions: (1) acceptance of the pedagogical approaches, (2) students’ reactions/learning efficacy, (3) perceived individual relevance of the content, and (4) perceived academic self-efficacy.

Most students rated Future Skills learning as important (83.4%) and stated that the workshop was helpful in familiarising them with the concept of Future Skills (85.2%) (ibid.). The content was also seen as personally relevant: 63.1% reported that the workshop helped them identify Future Skills that are personally meaningful. Students linked the relevance of Future Skills mainly to career development (75.0%) and personal development (74.5%), which supports integrating such learning into the curriculum (ibid.) Students located the importance of Future Skills primarily in relation to career development (75.0%) and personal development (74.5%), reinforcing the case for curriculum integration (ibid.). Consistent with this, demand for further Future Skills learning opportunities is high, especially in study-integrated formats, with a dichotomised approval rate of 68.5% (ibid.). Although the findings reflect an intervention rather than a fully scaled programme and are situated in a dual-study model, they nevertheless allow for strong conclusions regarding the quality of the intervention design and its suitability for fostering Future Skills.

3.5 Consequences for Future Skills Learning Designs

The evaluation results emphasise the importance of Future Skills and indicate a clear need for integrating Future Skills concepts more systematically into the dual-study curriculum. This implies a transformational shift in the way dual study programmes are designed, requiring the implementation of tailor-made learning formats that enable students to develop Future Skills autonomously and self-organised in order to successfully navigate a world of rapid change. In line with this, students explicitly call for more, and especially more visible, Future Skills learning opportunities throughout their studies. Consequently, learning designs should create favourable learning environments for Future Skills development, for example through peer feedback, continuous reflection flows, formative feedback, and authentic real-life experiences in situated learning settings.

3.6 Context at the university

To date, no integrated cross-campus Future Skills programme has been established at our university – for several reasons and because of barriers such as the complexity of decision and university-wide IT integration processes for the digital solutions such as apps and portfolio tools, the fragmentation of the university across campuses and locations, the variety of study programmes, dual partner organisations, accreditation processes or structures of theory and practice phases.

The Future Skills programme within project A is situated in a context characterised by heterogeneity - which, put positively, also gives room for exploration, experimentation and for trying out new approaches to design a modular Future Skills Programme for dual study pathways in an agile and participatory way, tested in educational practice contexts. One consequence is that, even in an exploratory mode, there cannot be a one-size-fits-all approach for Future Skills learning. The solution to be piloted is a Future Skills Toolbox for students and lecturers combined with a counselling process. The toolbox was developed in a design-based research process, involving students, the project team and dual practice partners.

3.7 Selection and counselling process

For testing new approaches, the team needed to find room for piloting in existing study programmes - with study coordinators willing to contribute to the further development of the programme and to integrate the resources and approaches increasingly into their own courses and programmes. For this purpose, an open call for participation was launched within the university, complemented by two digital information sessions. Nine study programmes from four campus locations and three faculties were selected in study programmes in the faculties of Business, Social Work, and Health. Several more study coordinators will participate in a more lightweight scenario in the next year. From the applicants, the participating study programmes were selected according to their range of disciplines, motivation to further develop and pursue the concepts during and after the piloting and to contribute to its evaluation and adaptation. The piloting will take place for first-, second- and third-year students.

The study coordinators were invited for one or several counselling sessions which aimed at collaboratively designing an adapted Future Skills programme from the Future Skills toolbox and addressed the following aspects:

- status quo of the study programme:
    - relevant topics and challenges
    - relevant FS-related topics and important Future Skills
- shared objectives
    - Motivation for participation
    - relevant aspects to consider for a successful cooperation and a meaningful learning experience
- conception phase
    - Which Future Skills-relevant elements are already established and how can they be connected to/combined with the toolbox?

  - Opportunities and barriers for integration
  - Which tools shall be used?
  - first ideas for implementation
  - involvement of Dual partners
  - Integration into the study year: dates, etc.
- Conclusion
  - open questions
  - Agreements and next steps

3.8 Toolbox and scenarios

In the counselling process, there is a certain freedom for adaptation, but also a minimal requirement of mandatory formats from the various elements of the Future Skills Toolbox (figure 2): a basic workshop for getting to know the concept and relevance of Future Skills and discovering one's own Future Skills profile, e.g. by implementing a general or adapted version of the Future Skills Compass as a reflection tool, as well as an introduction to the digital tools for self-directed learning, several reflection check-in meetings and a final workshop for taking stock of the Future Skills learning progress.

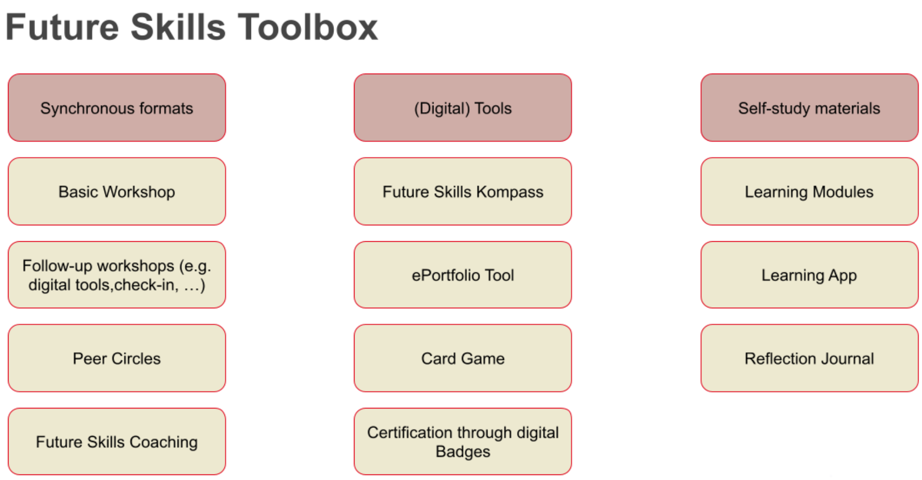

Figure 2. Future Skills Toolbox

A voluntary monthly coaching offer across participating as well as regular meetings with participating study coordinators and resources for dual partners and educators as well as a Moodle room, an ePortfolio tool for continuous documentation of Future Skills learning experiences, a learning app etc. complement the toolbox, allowing it to be tailored to course-internal and individual learning needs and contexts. Many activities take place in small peer circles of around four students which support one another in their Future Skills learning journey. Furthermore, a group coaching offer will be piloted in the second project year.

In the course of the counselling and conceptualisation processes, several different scenarios (cf. figure 3) have been developed, e.g.:

- the structured scenario: specific dates and scheduled times for self-study with scheduled "homework" for pacing of reflection
- the networked scenario: three participating courses from the same programme with different years, approaches and implementations, but shared resources such as an adapted version of the Future Skills Compass
- the innovative scenario: students develop resources and presentations on Future Skills and their discipline and present them in a final conference

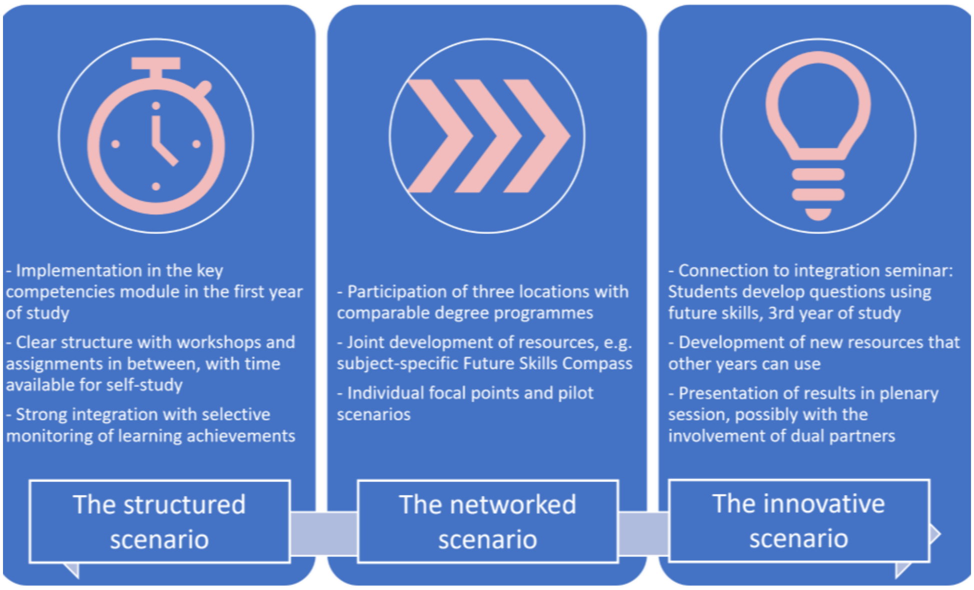

Figure 3. Different scenarios of integrating the Future Skills programme

3.9 Involvement of dual partners

At our university, dual partners employ students and also provide the practical learning space for dual students. Their role in the Future Skills learning process of students is crucial as most practical experiences take place during the learners' practice phases. Ideally, Future Skills learning would include reflection spaces and impulses both at the university and the workplace in an integrated and continuous way. However, involving dual partners in the Future Skills programme poses challenges: in some courses, students work and study at a multitude of different dual partners of various sizes, some of them explicitly fostering Future Skills through their own programmes. An info sheet was developed to be sent to dual partners by the study coordinators, providing some low-threshold ideas for supporting dual students' Future Skills development and inviting interested persons to become part of a community of practice for Future Skills development at the workplace. Moreover, some study coordinators explicitly involve persons from dual partners in the programme who are lecturers already.

3.10 Learnings for other contexts

While the Future Skills programme is being implemented in a specific dual study setting across different campuses and study programmes, several transferable insights can be derived that can inform the design and implementation of Future Skills initiatives in other contexts:

- While a shared competence framework is advised for orientation and developing a shared language with regard to Future Skills, there is no single uniform approach: Future Skills must be contextualised within the respective discipline in order to be seamlessly integrated.
- Continuous reflection and integration remain a challenge in intense study programmes with full curricula and little time for self-directed and interest-led studies as well as feedback processes. The integration of smaller reflection units as well as the use of digital tools can be a solution to extend the reflection impulses across theory and practice phases.
- The sustainability of the Future Skills challenge must be continuously discussed with involved educators and coordinators. Ideally, students, dual partners and other educators in a study programme are trained to support Future Skills development in their respective contexts.

Limitations of the case study are the (currently limited) availability of qualitative data and up-to-date quantitative data with regard to the current learning interventions taking place. These will be collected in the near term. Furthermore, the findings relate to a specific model of dual studies characterised by alternating theory and practice phases. Transferability to other study contexts must be critically discussed, especially in cases without close contact with industry partners.

4 Case Study 2: Digital Literacy as a key to developing transversal Future Skills

4.1 Theoretical background and setting

Digital literacy is now a key requirement for successful educational processes in universities and forms a core area of future-oriented academic skills development. However, its importance extends far beyond technical skills (Klier et al., 2021; Krempkow, 2021; Petri et al., 2024). In the context of current models such as the NextSkills Framework (Kirchherr et al., 2018), digital skills – including the IT skills identified therein – not only function as a separate cluster of skills, but also act as enablers for other Future Skills such as self-directed learning, critical thinking and collaborative working. Higher education research projects show that the promotion of digital competence – among students and teachers alike – can have a transformative effect when supported by didactic interventions (Authors 2; Hattermann et al., 2021).

The [B] model (Figure 4) was developed in a university-wide research process that included an empirical survey of teachers at various locations of our university (Authors 3). The five core areas of literacy – basic computer literacy, information literacy, media literacy, digital identity and career planning – are based on both university-specific requirements and reference frameworks such as the JISC Digital Literacy Framework (Holdener, Bellanger & Mohr, 2018).

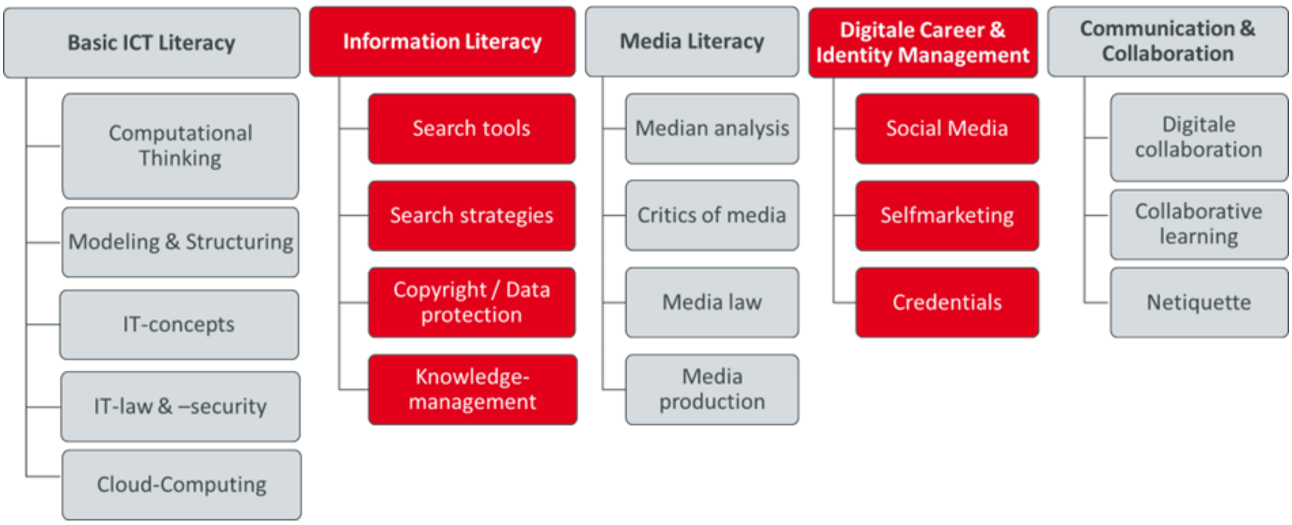

Figure 4. [B] - Aspects of Digital Literacy in students' education

In order to put this theoretical basis into practice, a modular, flexible online self-study course was developed (Authors 4). This course is designed to be used in a variety of teaching and learning scenarios – from voluntary self-study and blended-learning concepts to face-to-face formats such as preliminary courses or accompanying tutorials. The didactic design follows principles of both activation and competence orientation and uses digital learning formats (H5P elements, videos, interactive additional information, etc.). The aim is sustainable competence development that goes beyond the mere acquisition of knowledge.

4.2 Contents and didactic structure

The online course comprises four thematic modules that address different dimensions of digital literacy and also represent key areas of the [B] model. The topics are selected based on the results of a university-wide lecturer survey conducted in December 2022 (Authors 3). The course is designed to be a dynamic format that is continuously developed and adapted to the ongoing evolution of digital topics. As a result, the course content is constantly growing in line with the requirements of digital literacy, which are becoming increasingly complex and diverse. It is important to note at this point that the content is licensed under CC licences, so that existing, curated content could be used and adapted to individual needs. Although the topics covered in the course can be chosen freely by the users in any order, a particular focus during development was placed on basic computer science literacy. It is assumed that the confident, critical, and creative use of information and communication technologies benefits significantly from a fundamental understanding of how computers work and the principles of computer science (Koubek, 2005, p. 63).

The basic IT literacy module forms the technical core. It provides a fundamental understanding of digital systems, thereby laying the foundation for more advanced skills. The first lesson introduces the structure of computers, explains key components such as processors, memory and input/output devices, and traces the historical development from early computers such as ENIAC to modern mobile devices. The second lesson is devoted to human-computer interaction (HCI), analyses design principles of user-centred interaction independently of specific programming languages, and illustrates how technical systems are aligned with human perception and practical action. The module aims to enable students not only to use digital technologies functionally, but also to understand their basic logic. The intention is to strengthen learners' comprehension of programming operations and underlying algorithmic logic through the use of visual representational methods, particularly flowcharts (figure 5). Such visualisations support an accessible, language-agnostic engagement with computational procedures and are therefore considered a beneficial didactic resource in academic instruction (Schnirch et al., 2020; Kämper, 2003).

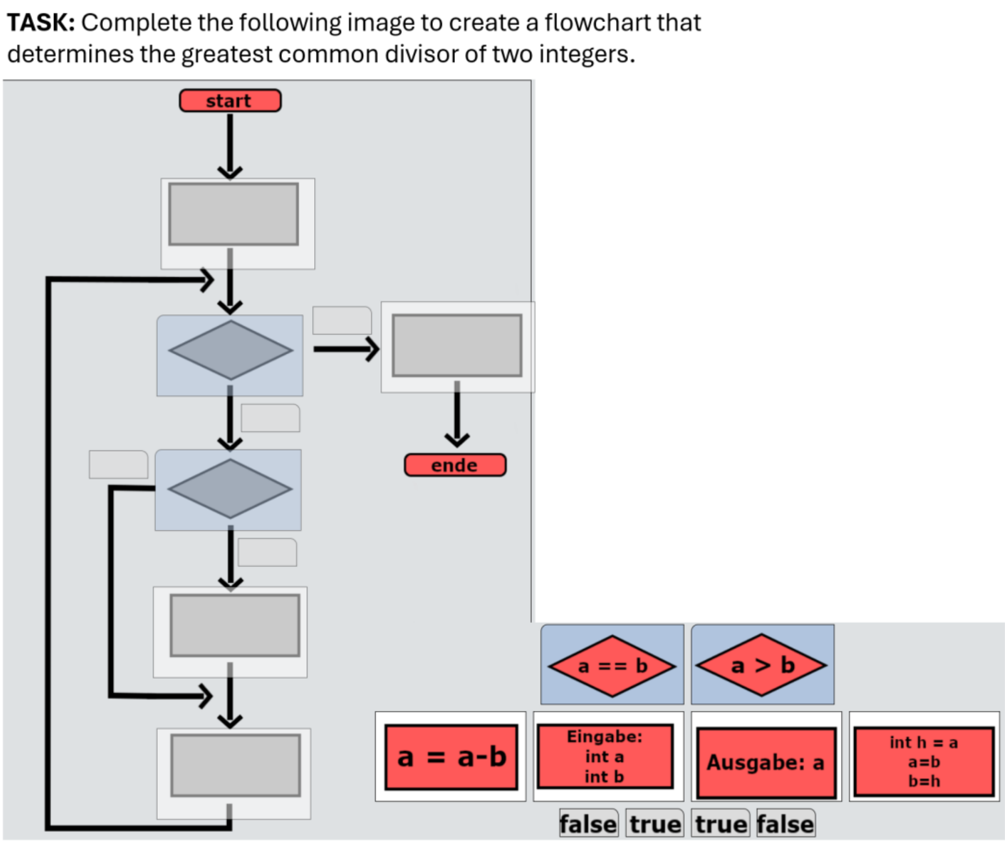

Figure 5. Algorithmic logic through the use of language-agnostic engagement

The information literacy module complements this technical foundation with the ability to use information spaces safely and reflectively. Topics covered include strategies for risk recognition, personal data protection, digital identity design, and security-conscious behaviour in everyday life. In addition, skills that are central to academic work are taught: information retrieval, source evaluation, structuring of research processes, and critical reflection on digital content. Information literacy is thus understood as a combination of digital security, media criticism and scientific information practice. The content of this lesson originates from the course "Schulung des Informationsbewusstseins" (information awareness training) - developed by Heilbronn University, Mannheim University, Reutlingen University, Freiburg University of Education, Karlsruhe University of Education, Weingarten University of Education, Esslingen University, and the DHBW (Cooperative State University Baden-Wuerttemberg) in collaboration with the Hochschulzentrum Baden-Württemberg. The overarching aim is to enhance awareness of potential risks and to equip learners with strategies for robust protection.

A central and highly topical module is AI competence for study and research. It teaches the basic functioning of artificial intelligence, explains the opportunities, risks and limitations of these technologies, and addresses questions of ethics and responsibility in particular. Students learn to critically evaluate AI systems and use them reflectively in academic processes – for example, in literature research, structuring scientific texts, analysing data, or reflecting on epistemic premises. A central objective of this module is to enable students to use AI in an informed and responsible manner, rather than adopting it uncritically or avoiding it out of uncertainty. It thus makes a significant contribution to the development of digital sovereignty.

The fourth module, digital reading literacy, addresses an area that is becoming increasingly important in the digital transformation. Digital reading literacy encompasses skills such as self-regulated reading, metacognitive control, critical comparison of multiple sources, and the ability to be epistemically vigilant. Students learn to strategically access digital texts, assess information quality, recognise cognitive biases, and consciously navigate digital information architectures. This makes digital literacy a key skill in academic work and in dealing with complex information environments.

The decision to map AI literacy and digital reading literacy as separate modules is based on two considerations: Firstly, both topics overlap with several areas of literacy in the [B] model – they encompass aspects of IT, information and media literacy as well as overarching reflective skills. Assigning them to a single area would not adequately reflect this complexity. Secondly, these are two areas of competence that are particularly prominent and dynamically growing in public and academic discourse, justifying in-depth, separate treatment. Presenting them separately allows for a clear focus on content and helps students to engage with these cross-cutting topics in a targeted manner. The implementation of this course has recently been completed and is starting to be used by students in the winter term 2025/26. For this reason, no evaluation data are yet available. One key focus will be the understanding of the role of guidance and supervision that might be needed in order to support the students' learning process best.

4.3 Reflections on limitations and scope of the case study "Digital Literacy"

While the case presented illustrates how digital literacy can act as a catalyst for the development of transversal Future Skills, several limitations must be taken into account in order to contextualise the results appropriately. First, the case is set in a single university offering dual education. The institutional environment is characterised by specific organisational structures, curricular traditions, and support mechanisms. The transferability of the approach described to other higher education contexts is considered very positive, however, empirical testing in other contexts has not yet been carried out. The willingness of the institution and the teaching staff, the available resources, and local educational cultures can significantly influence both the implementation processes and the learning outcomes. Second, the empirical basis of the present case study is currently still limited in terms of reliability. As already mentioned, the course was only recently implemented, so no systematically collected evaluation data are available yet. The analysis is therefore based primarily on didactic design principles and previous institutional experience with comparable teaching formats, rather than on validated outcome measures. Future research should therefore include longitudinal data collection, structured evaluation procedures, and comparative analyses in order to empirically substantiate statements on learning effectiveness and the development of subject-specific and interdisciplinary skills.

Thirdly, methodological limitations arise from the exploratory nature of the intervention. This article emphasises in particular the conceptual alignment between the [B] model presented and existing competence frameworks for Future Skills and digital literacy, but cannot demonstrate conclusive causal links empirically between specific teaching elements and the acquisition of transversal competences. The case should therefore currently be interpreted primarily as a theory-driven and empirically informed development example.

The explicit identification of these limitations helps to clarify the analytical scope of the study and enables transparent classification within current research on university teaching. At the same time, the case points to a key conceptual development: once students have acquired the basic digital literacy that enables them to participate in digital environments in a reflective and responsible manner, the focus in many departments is increasingly shifting to the question of which basic IT skills are necessary for a successful transition to university studies and for engaging with the course content.

This shift forms the content bridge to the following case study, which deals with computer literacy from a complementary perspective. While this section focuses on the institutional development of an online format for promoting digital literacy during the course of study, the following section looks at basic computer science competences that are considered essential in the transition from secondary school to university within a blended learning scenario. The subsequent case study thus broadens the perspective from digitally competent learners to academically prepared students who are able to engage with the conceptual foundations of computer science. At the same time, this provides further in-depth content: from overarching Future Skills to digital literacy to computer science competences as a sound technical foundation for academic work in the digital age.

5 Case study 3: Identifying and fostering key computer science competences as a key component of Future Skills

5.1 Theoretical background, setting and methodological approach

Computer science competences constitute a subset of digital literacy and therefore represent essential components of future-oriented skills (Ehlers, 2020). This section focuses on fostering fundamental computer science competences among prospective students in engineering degree programmes, based on a didactically grounded competency model. It is an example of supportive measures designed for students during the initial phase of their university studies.

First, the methodological approach used to identify relevant computer science competences during the transition from secondary school to university, is described briefly, followed by a presentation of the resulting findings. Subsequently, the didactic intervention designed to promote computer science competences among incoming first-year students, which builds on these findings, is introduced in more detail. This includes an outline of the systematic structure of the learning environment as well as selected excerpts from the course content. In addition, exemplary feedback from course participants is presented and interpreted with regard to the further development of the support programme.

To identify relevant fundamental computer science competences for the transition from secondary school to university, a Delphi study consisting of two survey rounds was conducted with lectures in computer science. (Authors 5) The general methodological procedure is shown in Figure 6.

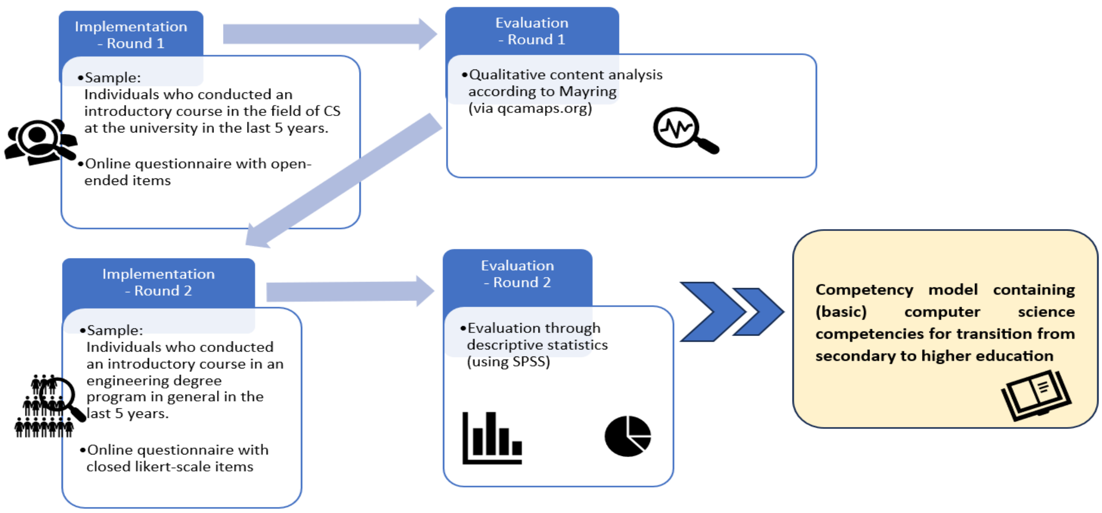

Figure 6. Methodological approach of the two-round Delphi study

In the first expert survey, individuals were asked who had conducted an introductory course in the field of computer science at the university within the past five years. The first survey round was carried out with a narrowly defined respondent group using an online questionnaire and included participants from the Department of Computer Science (e.g., Applied Computer Science, Business Informatics) at the university. The open-ended question items (n=4) are based on the questions used in the previously conducted study "MaLeMINT" (Schröter et al., 2022) and were adapted accordingly for the field of computer science. All items aim to identify relevant computer science competences needed for the transition from school to university. An example question is as follows:

„Which computer science competences should first-year students already possess at the beginning of a STEM degree programme?"

The results of the first survey round were evaluated through a summarising qualitative content analysis based on Mayring's approach. (Mayring, 2022).

In the second expert survey, individuals who had conducted an introductory course in the field of computer science at the university within the past five years were surveyed again. The sample for the second survey round was expanded to include not only teaching staff from the computer science department but also from all other engineering programmes (e.g., Mechatronics, Mechanical Engineering) at the University. The survey was again conducted using an online questionnaire. The questionnaire consists of a large number of closed-ended items that capture both content-related and process-related competences, thereby covering the various subfields of computer science. The individual competences are derived from the computer science competences identified in Round 1, as well as from competency descriptors found in the current curricula of the federal state of Baden-Württemberg for the subjects Computer Science (Ministerium für Kultus, Jugend und Sport Baden-Württemberg, 2018a, 2018a), IMP (Ministerium für Kultus, Jugend und Sport Baden-Württemberg, 2018b), NwT (Ministerium für Kultus, Jugend und Sport, 2023) and in the GI standards. (Hellmig et al., 2024; Röhner et al., 2016) Additionally, the questionnaire was cross-checked with insights from various expert workshops and supplemented in some cases. (Fallböhmer-Koob, 2024; Authors 6) This resulted in a comprehensive competency framework. For each listed competency, the questionnaire asks the following question:

„In your opinion, how important is the specified competency "X" for the transition from secondary school to an engineering degree programme?"

The response options, presented on a 6-point Likert scale, range from *„extremely important"* to *„not important at all"*. In addition, the respondents were asked to rank certain content-related and process-related areas of competence in order of their overall importance. The evaluation of the questionnaire results is carried out using descriptive statistics.

The following process-related areas of competence were available for selection:

- justify and evaluate
- communicate and collaborate
- present and interpret
- modelling and implementation
- structuring and networking

The following content-related areas of competence were available for selection:

- information and data
- algorithms
- information processing
- computer systems
- data collecting and analysis
- electronic systems
- languages and automata

5.2 Results and their use in developing the competency model: Basic Computer Science Competences for the Transition from Secondary to Higher Education

In the following, the development of the competency model will be presented and explained in some detail (additional information may be found in Authors 7). Figure 7 shows the graphical representation of the competency model of basic computer science competences for the transition from school to university. The model is divided into process-related areas of competence (such as "structuring and networking" – outer circle in figure 7) and domain-specific areas of competence (such as "algorithms" – inner circle in the figure). Each competency area comprises the individual competences assigned to it, which were identified during the two survey rounds.

The individual competences of both areas should not be viewed in isolation from each other. They are closely interwoven during the learning process and are in constant interaction. The individual competences of the process-related competences are formulated independently of specific topics. When combined with various content-related competences from the respective content-related areas, they can be further developed.

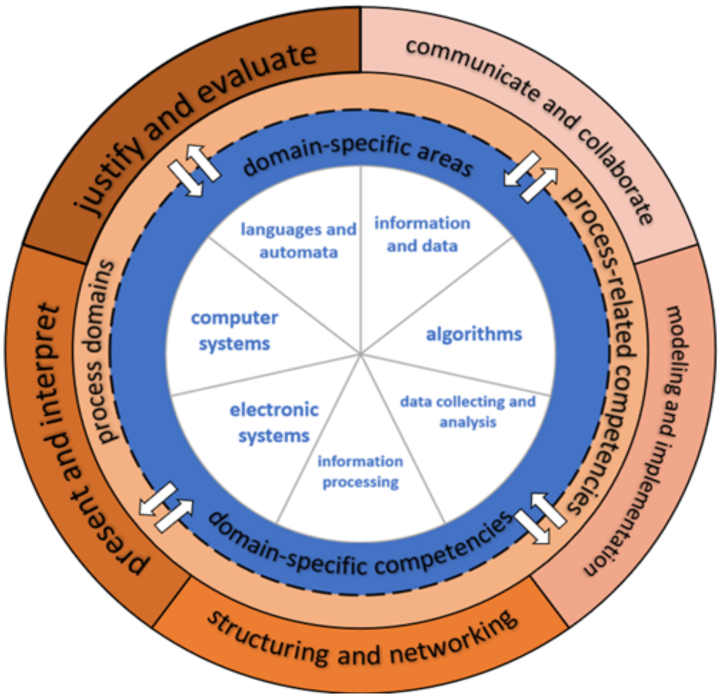

Figure 7. Competency model of basic informatics competences for the transition from school to university

Figure 8 shows the averaged rankings of the content-related and process-related competence areas. Information and data are rated by the experts as by far the most relevant domain-specific competence area for the transition from school to university. Justify and evaluate was considered the most relevant process domain.

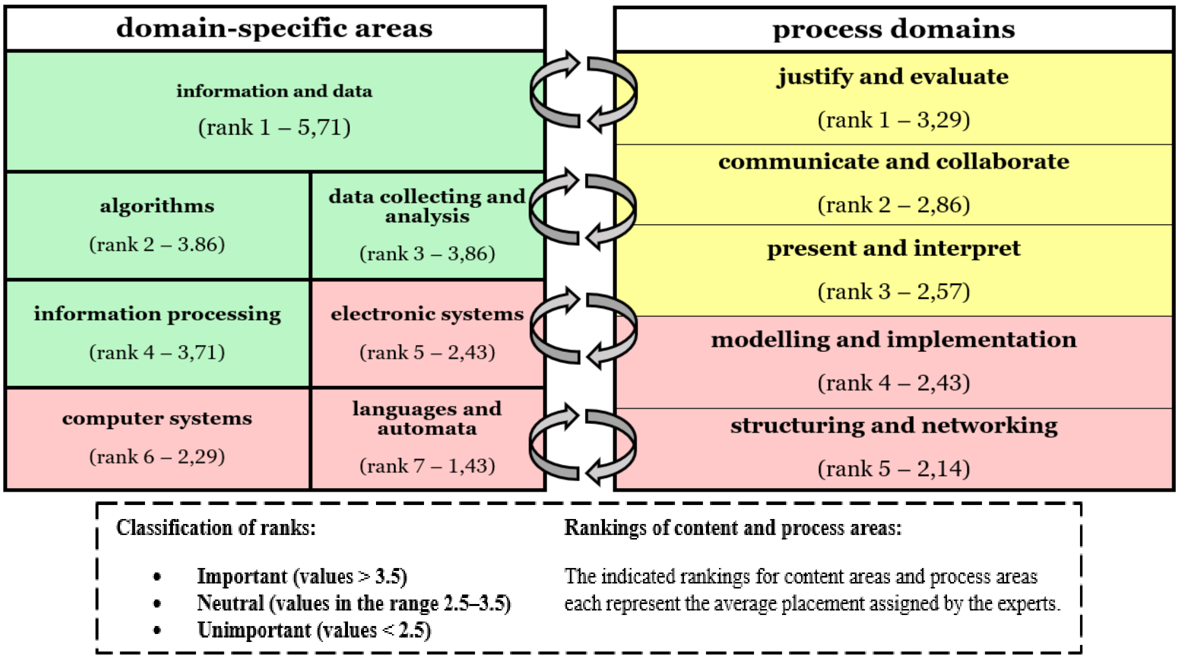

Figure 8. Ranking of the content-related and process-related competence areas (six-point Likert scale)

With regard to the generalisability of the results obtained, limitations must be expected given the size of the sample (n=9) Nevertheless, the findings provide indicative trends for the development of support measures in the field of computer science during the school-to-university transition.

5.3 A brief overview: Key elements of the supportive measure to foster key computer science competences

The preliminary course lasts five consecutive days: During the first two days, fundamental skills and competences in the areas of Python programming and electrical engineering are taught. Over the following three days, participants apply the knowledge gained during the theoretical phase to implement their own project ideas. The learning environment is governed by a high degree of active engagement and independence afforded to the learners. At the same time, the differentiated learning materials provided enable learning at one's own pace and in accordance with individual prior knowledge. This also provides the instructor with the necessary flexibility to provide targeted support to individual participants. In doing so, the instructor adopts the role of a „learning facilitator" and is able to quickly respond to learners' individual questions and difficulties.

The course takes place in person, with participants provided with the necessary technical infrastructure. Desktop computers with internet access are made available for this purpose. The classroom is complemented by digital learning materials, which have been specially prepared on the Moodle platform for independent learning and provide individual learning modules with informational content and differentiating learning tasks. The integrated development environment 'Thonny' is used to create the participants' own programs. This programming environment offers various quality-of-life features, such as a simple debugger, syntax error highlighting, and clear visualisation of variables and their values, which can positively support the learning process when learning how to code.

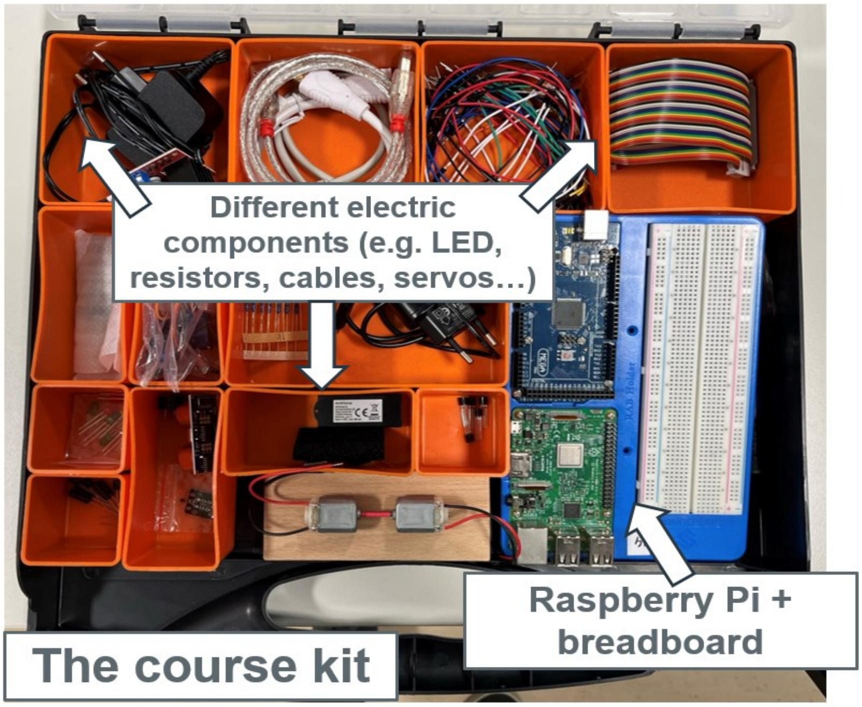

Figure 9. The physical learning materials of the course kit

Central to the learning process are appropriate materials that allow learners to experiment and gain hands-on experience. Figure 9 shows the provided experimental materials for building electrical circuits. These include, in addition to a Raspberry Pi as a programmable single-board computer, common electrical components such as resistors, LEDs, servo motors, and connecting cables.

5.4 Insights and impressions from the course sessions

Over the course of the five days, learners are enabled to implement their own projects largely independently. Looking at the project implementations (as shown on figure 10), it becomes clear that, with the provided resources (e.g., classroom, learning materials, and individual guidance from instructors), participants with little or no prior experience in computer science are empowered to connect computer science content with aspects of electrical engineering.

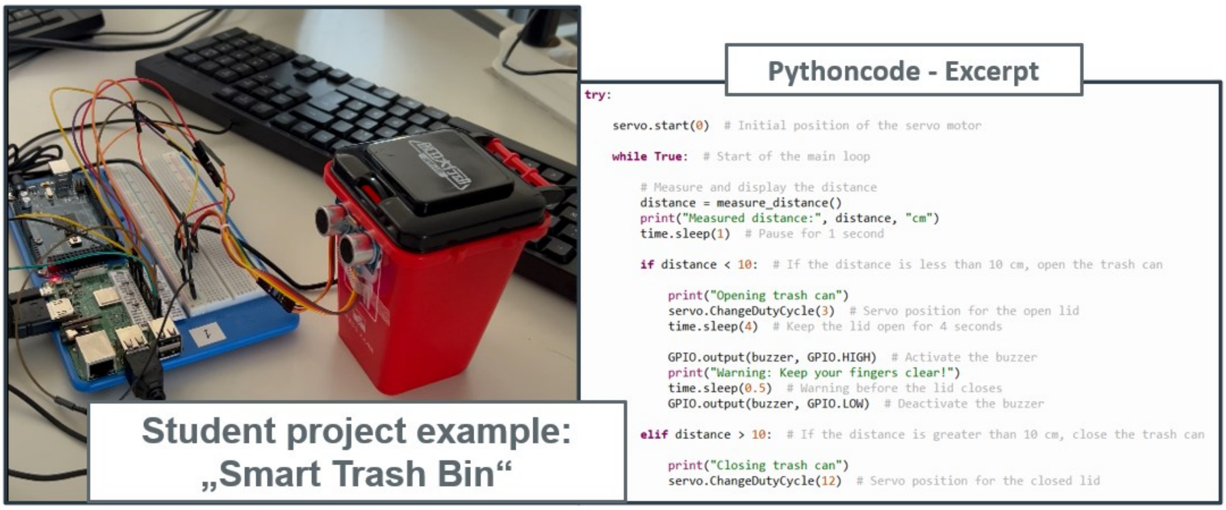

Figure 10. Student project: Smart Trash Bin”

5.5 Feedback from participating students

The implementation of the learning programme is subject to systematic evaluation, on the basis of which the course is continuously developed and improved. The following are frequently recurring examples of feedback comments from the course participants:

- “I really appreciated the high proportion of independent work and learning of the topics discussed.”
- “Combination of theory and practice: working independently with a partner, with guidance and explanations available for questions.”
- “Being able to apply everything myself and let my creativity run freely in the projects.”
- “Independent acquisition of competences and free project work; being able to work at one’s own pace.”
- “The overall concept and the different selectable difficulty levels.”

Consequently, the aspects of „space for independent work / working at one’s own pace“, „linking theory and practice / applying theoretical content“, and the opportunity to „implement one’s own project ideas“ are particularly highly valued by the participants.

5.6 Limitations of the results

Four main limitations should be noted: First, with regard to the generalisability of the results obtained, limitations must be expected given the small sample size for the two rounds of the Delphi study. Nevertheless, the findings provide indicative trends for the development of support measures in the field of computer science during the school-to-university transition. The latter were evaluated with the course participants.

Second, process-related and content-related competences are closely interrelated. Based on the investigation presented here, no definitive statements can be made about the extent to which certain combinations of process-related and content-related competences are considered particularly relevant. This limitation must be taken into account when interpreting the survey results. Collecting data on relevant combinations within the presented survey would have significantly expanded the scope of an already extensive questionnaire. Therefore, in view of the test’s completion time and overall feasibility, this specific perspective was omitted. Likewise, only limited statements can be made about the specific (Bloom’s) levels (Krathwohl et al., 1975) at which certain individual competences should primarily be fostered.

Third, the model development and the evaluation have taken place at a single work-integrated university. Therefore, results of this case study may not be transferred one-to-one to other types of universities. Nevertheless, to our knowledge, the preparatory course design for key computer science competences is expected to run as well in other institutions of higher education.

6 Conclusions and outlook

6.1 Conclusions

This paper presented and discussed case studies addressing three related competence fields of Future Skills, digital literacy and computer science. Considered as transversal skills, these domains emerge from the integration of technical, cognitive and reflective dimensions and constitute an important foundation for future-oriented higher education.

The analysis was guided by three research questions, which are addressed here based on the collective insights developed in chapters 3-5. Regarding **research question 1**, chapter 3 examined how Future Skills could be meaningfully integrated into higher education curricula across diverse disciplinary and institutional contexts, particularly within dual study programmes. The case study demonstrates that Future Skills can be institutionally embedded within classical curricula, as their development represents a university-wide responsibility involving both students and teaching staff which requires alignment with curricula and quality assurance processes. The implementation of self-directed learning formats shows high potential when supported by appropriate didactic design – verified by the experience gained in the case study Future Skills. In particular, the toolbox concept offers considerable flexibility and adaptability for students, especially those in higher semesters or to other educational contexts. Collaboratively, different explored scenarios for Future Skills learning can serve as a blueprint. As Future Skills subsume many different kinds of competences, the tool box approach turns out to be very appropriate in order to allow selecting the best fitting ones for any given learning situation and setting. From a pedagogical point of view, the reflexive learning process is also strongly supported by the use of supervision, peer activities and ePortfolio.

Research question 2 addresses the role of digital literacy and computer science competences as enabling or constitutive elements of Future Skills development. As a transversal future skill, digital literacy may be considered as a key enabling competence that supports self-directed learning, critical thinking and digital sovereignty. Rather than focusing solely on technical proficiency, digital literacy includes reflective and responsible engagement with digital technologies. In the presented approach, [B] provides a structured, yet flexible competence model that integrates multiple competence dimensions, including basic IT literacy, information literacy, AI literacy and digital reading literacy. The corresponding online course illustrates how theory can be translated into scalable practice. By fostering a foundational understanding of digital technologies, the approach contributes to reducing black-box use and supports interdisciplinary accessibility through language- and tool-independent concepts. Finally, AI literacy and digital reading literacy are emerging key domains.

Computer science competences represent a more specialised and highly relevant subset within this competence spectrum and therefore represent essential components of future-oriented skills. Their strong connection to the practical problem solving makes them suitable for development in hands-on courses within engineering degree programmes, where students apply these competences in authentic project contexts. Such learning environments support not only acquisition of technical knowledge but also the development of problem-solving, analytical, and adaptive skills that are essential for their future careers – Future Skills. Unlike the other two case studies the computer science course primarily functions as an entry-level format designed to establish a baseline for further competence development at the beginning of students' studies, because in IT-affine study programmes, more advanced competences are already further developed within the traditional curricula.

Research question 3 focused on pedagogical design principles and learning environments that support sustainable competence development across the three domains. Across the case studies several converging insights and key learnings emerged:

1. **Modular design and flexibility**: All three approaches employ modular structures that allow huge flexibility and adaptability to different disciplines, structures and institutions of higher education, the phase within the student live cycle they take place as well as the needs and requirements of the lecturers and supervisors. This approach proved effective in all three case studies as it strongly supports learner autonomy and enables implementation in diverse learning contexts.
2. **Reflection as a core element of competence development**: The case study implementations are grounded and accompanied by a pronounced student reflection process which is designed to be an integral part of the competence development process. This requires learning designs that offer favourable learning environments for the skill development such as peer feedback, formative feedback, and real-life experiences and situated learning. And the evaluations showed clearly that these attempts were strongly acknowledged by the participants.
3. **Importance of guidance and supervision**: The approaches used within the case studies prove most effective when supported by counselling and/or supervision.
4. **Pedagogical embedding**: A successful implementation of formats, as described in the case studies, requires appropriate pedagogical embedding that takes differences in students' prior knowledge and self-regulation abilities into account. In particular, forms of self-directed learning should complement, not replace, guided instruction.

5. **Continuous evaluation and development**: To ensure sustainability and relevance, continuous updates and empirical evaluations of the case studies are required: learning outcomes, transfer into study practices and long-term literacy development.

Nevertheless, the presented case studies show as well some divergences: The possible range of didactic implications of self-directed learning formats range from purely online self-learning elements to (supervised and unsupervised) blended-learning to full-time face-to-face courses. In addition, they are offered for different durations (one week, one term or several years) and timing within the student life cycle (study entry phase, first year of study, last two years). However, these differences do not weaken the overall approach; rather they demonstrate the flexibility of competence-oriented learning designs. And even though all case studies were implemented at a single university, most elements are designed in a way that allows relatively straightforward adaptation and transfer to other higher education institutions.

Importantly, these divergences also reveal potential for cross-case development. For example, the self-learning approach of the course on digital literacy may benefit from additional supervision and closer collaboration with dual partners, drawing on experiences from the Future Skills case study. In addition, the Future Skills and digital literacy might profit from the idea to start with the basic competence development already with freshman students similar to the computer science preparatory course. Further opportunities exist in the area of evaluation: the online-course for digital literacy could incorporate additional quantitative and qualitative assessment methods successfully used in the other two case studies. And finally, the other two case studies may benefit from the implementation of a pre-/post-test design similar to those applied in the computer science context.

Common limitations across the three case studies are: (1) The limited availability of data, both qualitative and quantitative due to small sample sizes. (2) Due to the interrelation of different types of competences (process-related, content-related, …), it is difficult to say which certain combinations thereof are considered particularly relevant. (3) The interventions took place at a single work-integrated university.

These limitations may be addressed through Future research that includes longitudinal data collection, structured evaluation procedures, and comparative analyses in order to empirically substantiate statements on learning effectiveness and the development of subject-specific and interdisciplinary skills ((1) and (2)). This research should also take place at other institutions of higher education (3).

Transferability to other study contexts must be critically discussed, especially in cases with no close contact to industry partners. Empirical testing in other contexts is needed.

6.2 Outlook and future research

The case studies presented in this paper are still in place and used on a regular basis. In line with the DBR approach they are continuously evaluated, adapted and improved. For example, the **Future Skills** programme is implemented in different adapted scenarios. This allows the project team to systematically investigate which learning settings, tools and scenarios most effectively support students in developing Future Skills – and which approaches prove less successful. To support this process, a multi-step evaluation process is being implemented with links to DBR approach, involving educators, students, and participating study coordinators in quantitative and mostly qualitative evaluation processes. This iterative evaluation aims to identify barriers, enabling conditions, and opportunities for further refinement and development. Ultimately, the goal is to develop a theory- and evidence-based blueprint for Future Skills learning in dual study programmes. In addition, the agile adaptation of the originally planned outline in the unfolding study year represents an interesting subject for further research. While the resources and tools have been developed and adapted to a dual higher education context, the resources can be adapted to other higher education and learning contexts as well - provided there is room for experiences and continuous reflection of theory, practice and competence development.

For the **digital literacy** case study, further validation of the competence development remains an important research objective. First, future research could examine the interactions between students' and teachers' digital literacy and the implications of these dynamics for teaching and learning processes. Second, as part of the Future Skills set there is the need for ongoing adaptation to emerging technologies and epistemic challenges. Third, it remains to be explored to what extent pedagogical elements – such as supervision and the systematic use of ePortfolios – can be integrated into the learning design to further support reflective competence development.

The computer science preparatory course is continuously improved based on feedback from participants and instructors. In addition to expanding the range of materials for potential project implementations, the learning materials - such as the scope of differentiated assignments - are also being further developed. Currently, a diagnostic instrument in the form of a pre- and post-test is being developed for the funding initiative, covering the areas of “Algorithms”, “Programming”, “Logic” and “Overview: Computer Science”. Within the preparatory course, it is intended to assess existing computer science knowledge before and after the course. This testing procedure is currently in the piloting phase.

As already mentioned, concerning the use and adaptation of the cases for other institutions of higher education the case studies offer a huge **transfer potential**. The case studies on digital literacy and key computer science competences do not rely on the work-integrated nature of our university. So, the findings may be transferred rather easily to other institutions of higher education. Concerning the case study on Future Skills the given flexibility allows most aspects to transfer, but for all aspects with dual partners’ involvement a possible transfer and necessary modifications must be evaluated more thoroughly by evaluating the case studies at other institutions of higher education.

Statement

The peer-review process and editorial decision were handled independently by members of the Editorial Board who were not involved as authors. The authors took no part in the review or decision-making process.

References

Bianchi, G., Pisiotis, U., & Cabrera Giraldez, M. (2022). *GreenComp: The European sustainability competence framework* (Y. Punie & M. Bacigalupo, Eds.; EUR 30955 EN; JRC128040). Publications Office of the European Union. https://doi.org/10.2760/13286

Design-Based Research Collective. (2003). Design-based research: An emerging paradigm for educational inquiry. *Educational Researcher*, 32(1), 5–8.

Ehlers, U.-D. (2020*). Future Skills: Lernen der Zukunft – Hochschule der Zukunft [Future Skills: Learning of the future – University of the future].* Springer https://doi.org/10.1007/978-3-658-29297-3

Fallböhmer-Koob, A. (Ed.) (2024). *Kreidezeit?! Kompetenzentwicklung an Hochschulen für das 21. Jahrhundert*. University of Applied Science Kaiserslautern. [Kreidezeit?! Competence Development at Higher Education Institutions for the 21st Century. Kaiserslautern University of Applied Sciences.] https://doi.org/10.57997/3h83-hr89

García-Álvarez, J., Vázquez-Rodríguez, A., Quiroga-Carrillo, A., & Priegue Caamaño, D. (2022). Transversal competences for employability in university graduates: A systematic review from the employers’ perspective. *Education Sciences*, 12(3), 204. https://doi.org/10.3390/educsci12030204

Hattermann, M., Salle, A., Schumacher, S., & Heinrich, D. C. (2021). Zusammenfassung der Ergebnisse und Transfermöglichkeiten in die Hochschulpraxis. In*: Mathematiklernen mit Digitalen Medien an der Hochschule: Konzepte, Umsetzungen und Ergebnisse aus dem Projekt Mamdim* (S. 289–293) [Summary of results and possibilities for transfer to higher education practice. In: Learning Mathematics with Digital Media in Higher Education: Concepts, Implementations, and Results from the Mamdim Project (pp. 289–293)] Springer Fachmedien Wiesbaden GmbH.

Hellmig, L., Burk, S., Greubel, A., Hennecke, M., Herper, H., Hilbig, A., Michaeli, T., Mittag, A., Pasternak, A., Puhlmann, H., Röhner, G., Rücker, M., Schmalfeldt, T., Spalteholz, W., & Stechert, P. (2024). *Empfehlungen der Gesellschaft für Informatik e.V.: Bildungsstandards Informatik für die Sekundarstufe I [Recommendations of the German Informatics Society (GI): Educational Standards in Informatics for Lower Secondary Education]*. https://informatikstandards.de/fileadmin/FA/IBS/user_upload/Bildungsstandards_Sek_I_2025__pdf-A_.pdf

Holdener, A., Bellanger, S., & Mohr, S. (2018). *„Digitale Kompetenz“ als hochschulweiter Bezugsrahmen in einem Strategieentwicklungsprozess*. ["Digital literacy" as a university-wide frame of reference in a strategy development process.] https://doi.org/10.25656/01:15780

Kämper, S. (2003). Algorithmenentwurf. In: S. Kämper (Hrsg.), *Grundkurs Programmieren mit Visual Basic: Die Grundlagen der Programmierung—Einfach, verständlich und mit leicht nachvollziehbaren Beispielen* (S. 1–21). [Basic Course in Programming with Visual Basic: The Fundamentals of Programming—Simple, clear, and with easy-to-follow examples (pp. 1–21)] Vieweg+Teubner Verlag. https://doi.org/10.1007/978-3-322-92940-2_1

Kirchherr, J., Klier, J., Lehmann-Brauns, C., & Winde, M. (2018). *Future Skills: Welche Kompetenzen in Deutschland fehlen. [Future Skills: Which Competencies Are Lacking in Germany] 11.*
Klier, J., Winde, M., Projektteam Stifterverband, & Projektteam McKinsey Company. (2021). *Future Skills 2021—21 Kompetenzen für eine Welt im Wandel. [Future Skills 2021—21 Competencies for a Changing World.]* https://www.stifterverband.org/medien/future-skills-2021
Kolb, D. A. (1984). *Experimental learning: Experience as the source of learning and development*. Prentice-Hall.
Koubek, J. (2005). Informatische Allgemeinbildung. In: S. Friedrich & Gesellschaft für Informatik (Hrsg.), *Unterrichtskonzepte für informatische Bildung* (S. 57–66). Ges. für Informatik. [General Informatics Education. In S. Friedrich & German Informatics Society (Eds.), Teaching Concepts for Informatics Education (pp. 57–66). German Informatics Society.]
Kovalcik, B. (2019). Developing employability skill articulation in college students: A framework and practitioner approaches for co-curricular educators. *Journal of Campus Activities Practice and Scholarship*, 1(2), 26–31. https://doi.org/10.52499/2019013
Krathwohl, D. R., Bloom, B. S., & Masia, B. B. (1975). Taxonomie von Lernzielen im affektiven Bereich (H. Dreesmann, Trans.*). Beltz-Studienbuch*: Vol. 85. Beltz.
Krempkow, R. (2021). Wie digital kompetent sind Studierende? Ein Konzept und Erhebungsinstrument zur Erfassung digitaler und fächerübergreifender Kompetenzen. *Qualität in der Wissenschaft*, 22–29. [How digitally competent are students? A concept and assessment tool for measuring digital and cross-disciplinary competencies. Qualität in der Wissenschaft, 22–29.]
Mandl, H., & Krause, U. M. (2001). *Lernkompetenz für die Wissensgesellschaft*. München: Ludwig-Maximilians-Universität
Mayring, P. (2022). *Qualitative Inhaltsanalyse: Grundlagen und Techniken* (13., überarbeitete Auflage). [Learning Competence for the Knowledge Society. Munich: Ludwig Maximilian University
Mayring, P. (2022). Qualitative Content Analysis: Foundations and Techniques (13th, revised edition).] Beltz. https://www.content-select.com/index.php?id=bib_view&ean=9783407258991
Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation* (4th ed.). Jossey-Bass. Ministerium für Kultus, Jugend und Sport (Ed.). (2023).
Bildungsplan 2016: *Naturwissenschaft und Technik (NwT): Basisfach in der Kursstufe*. [2016 Curriculum: Natural Sciences and Technology: Basic Subject in the Upper Secondary Phase] https://informatikstandards.de/fileadmin/FA/IBS/user_upload/Bildungsstandards_Sek_I_2025__pdf-A_.pdf
Ministerium für Kultus, Jugend und Sport Baden-Württemberg (Ed.). (2018a). *Bildungsplan 2016: Aufbaukurs Informatik*.[Ministry of Education, Youth and Sports Baden-Württemberg (Ed.). (2018a). Curriculum:2016: Advanced Computer Science Course.] https://bildungsplaene-bw.de/site/bildungsplan/get/documents/lsbw/export-pdf/depot-pdf/ALLG/BP2016BW_ALLG_SEK1_INF7.pdf
Ministerium für Kultus, Jugend und Sport Baden-Württemberg (Ed.). (2018b). *Bildungsplan 2016: Informatik, Mathematik, Physik (IMP): Profilfach*. [Ministry of Education, Youth and Sports Baden-Württemberg (Ed.). (2018b). Curriculum 2016: Computer Science, Mathematics, Physics (IMP): Profile Subject.] https://www.bildungsplaene-bw.de/,Lde/BP2016BW_ALLG_GYM_IMP
Mordhorst, L., & Jenert, T. (2023). Curricular integration of academic and vocational education: A theory-based empirical typology of dual study programmes in Germany. *Higher Education*, 85, 1257–1279. https://doi.org/10.1007/s10734-022-00889-7
OECD. (2019). OECD Learning Compass 2030: A series of concept notes. OECD.
Petri, P. S., Krempkow, R., Ebner, M., & Getto, B. (2024). Editorial: Digitale Kompetenzen—Zur Rolle dieser „Future Skills“ im Hochschulkontext: Definition und Bedeutsamkeit, Messung und Förderung. *Zeitschrift für Hochschulentwicklung*, 19(1). [Editorial: Digital Literacy—On the Role of these “Future Skills” in the Higher Education Context: Definition and Significance, Measurement and Fostering. Journal for Higher Education Development, 19(1)] https://doi.org/10.21240/zfhe/19-01/01
Röhner, G., Brinda, T., Denke, V., Hellmig, L., Heußer, T., Pasternak, A., Schwill, A., & Seiffert, M. (2016). *Bildungsstandards Informatik für die Sekundarstufe II: Empfehlungen der Gesellschaft für Informatik e. V.* [Educational Standards in Computer Science for Upper Secondary Education: Recommendations of the German Informatics Society.] https://informatikstandards.de/fileadmin/GI/Projekte/Informatikstandards/Dokumente/Bildungsstandards_SII.pdf
Schnirch, A., Ridinger, N., & Weschenfelder, F. (2020). *Raspberry Pi im Informatik- und Technikunterricht: Konzeption eines handlungs- und problemorientierten Unterrichts mit der MicroBerry-Lernumgebung*. Springer Fachmedien. [Raspberry Pi in Computer Science and Technology Education: Designing Action- and Problem-Oriented Lessons Using the MicroBerry Learning Environment. Springer Fachmedien] https://doi.org/10.1007/978-3-658-28793-1
Schön, D. A. (1983). *The reflective practitioner: how professionals think in action*. Basic Books.
Schröter, P., Groß, A., Schmid-Kühn, S. M., Stanat, P., & Hoffmann, L. (2022). Das unvergleichliche Abitur. wbv Publikation. [The Incomparable University entrance exam. wbv Publication] https://doi.org/10.3278/9783763972494
Seligman, M. E. P., & Csikszentmihalyi, M. (2000). Positive psychology: An introduction. *American Psychologist*, 55(1), 5–14
Stake, R. E. (1995). *The art of case study research*. SAGE.
Wang, F., & Hannafin, M. J. (2005). Design-based research and technology-enhanced learning environments. *Educational Technology Research and Development*, 53(4), 5–23.
Weinert, F. E. (2001). Concept of competence: A conceptual clarification. In D. S. Rychen & L. H. Salganik (Eds.), *Defining and selecting key competences* (pp. 45–65). Göttingen: Hogrefe & Huber.

Yan, Z., & Boud, D. (2022). Conceptualising assessment-as-learning. In Z. Yan & L. Yang (Eds.), Asia-Europe education dialogue. *Assessment as learning: Maximising opportunities for student learning and achievement* (pp. 11–24). Routledge Taylor & Francis Group

Yin, R. K. (2018). *Case study research and applications* (Vol. 6). Thousand Oaks, CA: Sage