Adaptive and Re-adaptive Pedagogies in Higher Education: A Comparative, Longitudinal Study of Their Impact on Professional Competence Development across Diverse Curricula

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Abstract:

This study addresses concerns that traditional, lecture-based teaching methods may not sufficiently develop the integrated competencies demanded by modern professional practice. A disconnect exists between conventional pedagogy and desired learning outcomes, prompting increased interest in innovative, student-centered instructional models tailored to competence growth. Despite this, nuanced differences in competence development across diverse university curricula remain underexplored, with research predominantly relying on students' self-assessments. To address these gaps, this study employs longitudinal mixed-methods approaches with regard to theory triangulation and investigator triangulation to better understand how professional knowledge, skills, and dispositions evolve across varied curricula and contexts. This research emphasizes adaptive and re-adaptive teaching approaches incorporating technology, individualization, and experiential learning, which may uniquely integrate skill development with contextual conceptual learning. Specific attention is paid to professional education paths like design, media, and communications degrees, where contemporary competence models stress capabilities beyond core conceptual knowledge. Results from this study aim to guide reform efforts to optimize professional competence development across diverse academic areas.

Introduction

Developing professional competence has become a critical aim in higher education as universities seek to equip students with the multifaceted knowledge, skills, and attributes needed to handle complex roles in today's world (Rowe & Zegwaard, 2017; Mulder, 2016). However, concerns have emerged that traditional, lecture-based teaching methods in many academic programs may not provide optimal conditions for fostering the integrated competencies demanded by modern professional practice (Boelt, Kolmos, & Holgaard, 2022). Passive, transmission-focused instruction has been associated with superficial learning focused on short-term retention rather than the more profound development of transferrable capabilities (Biggs, Tang, & Kennedy, 2022). This disconnect between conventional pedagogy and desired learning

outcomes represents a key impetus driving increased interest in innovative, student-centered instructional models tailored to competence growth (Köseoğlu, Veletsianos, & Rowell, 2023; Darby & Lang, 2019; Veletsianos, 2016; Baroncelli et al., 2013).

One major limitation highlighted in comparative international research is that nuanced differences in professional competence development across diverse university curricula remain underexplored (Moro, Moro, and Gallardo-Pérez, 2019; Deardorff & Arasaratnam-Smith, 2017; Jackson & Wilton, 2016). For instance, while studies have shown that early childhood educators with Bachelor's degrees demonstrate greater expertise than those without university qualifications (Whitebook, 2003; Clegg, Tan, & Saedi, 2022), few studies have examined variances in competence acquisition across academic programs utilizing different pedagogies, learning activities, and fieldwork components. Furthermore, research on competence development in higher education relies predominantly on students' self-assessments via surveys and reflections (Lozano et al., 2017; Ling & Venesaar, 2015). While valuable, self-reporting provides only one perspective on the complex, multifaceted processes underlying competence growth.

To address these gaps, expanded research utilizing longitudinal mixed-methods approaches is needed to better understand how professional knowledge, skills, and dispositions evolve across diverse university curricula and instructional contexts (Scharenberg et al., 2021; Kim, Jung, & Tracey-Ventura; Baguley et al., 2014). Combining self-assessments with more objective competence measures at multiple points can yield better insights into learning trajectories (Sztajin & Wilson, 2019). Comparative studies evaluating emerging instructional models are also vital (Jaafar & Pedersen, 2021). In particular, adaptive and re-adaptive teaching approaches leveraging technology, individualization, and experiential learning may hold unique potential to integrate skill development with conceptual learning in context (Turel, 2021; Sein-Echaluce, Fidalgo-Blanco, & García-Peñalvo, 2019; Westwood,

2018; Bakharia et al., 2016). Investigating implementation and outcomes across disciplines can inform pedagogical improvements.

Specific research is warranted on professional education paths such as design (games, ux, and audio), media, and communications degrees, where contemporary competence models emphasize creative thinking, digital literacy, and other capabilities beyond core conceptual knowledge (De Pablos Patricia, Lytras, & Zhang, 2020; Spante et al., 2018; Reynolds, 2016). Comparative studies explicitly contrasting competence development across traditional lecture-based versus innovative adaptive and re-adaptive curricula in these applied contexts could illuminate specialized needs and guide pedagogical improvements tailored to these fields (Cook, Klein, & Chen, 2019). For instance, mapping how creative problem-solving skills evolve between student cohorts exposed to standardized versus personalized adaptive course sequences could inform specialized instructional reforms (Augstein, Herder, & Wörndl, 2023; Phillips et al., 2020). Expanding comparative research on emerging instructional approaches using robust multidimensional methodologies can provide vital insights to guide reform efforts to optimize professional competence and capability development across diverse and specialized academic areas.

Materials and Methods

A systematic search strategy aligned with PRISMA guidelines was utilized to comprehensively identify studies for inclusion in this review (Page et al., 2021). Three major education databases – ERIC, Education Source, and PsychINFO – were searched in July 2023 using combinations of relevant keywords, including "adaptive learning," "higher education," "professional competence," "development," "outcomes," and synonyms. Search terms were adapted for each database using appropriate syntax, tags, and index terminology. The search was limited to peer-reviewed empirical studies published in English between 2017 and 2022.

After removing duplicates, the titles and abstracts of 342 records were screened for alignment with the review scope and questions. Inclusion criteria at this stage required that studies examine adaptive or re-adaptive learning approaches, are implemented in higher education contexts, and include measures related to professional competence development and/or outcomes. 75 full-text articles were assessed for eligibility based on these criteria. An additional 37 relevant sources were identified by hand-searching the key articles' reference lists.

Ultimately, 25 studies met the full criteria and were included in the literature review, as shown. Reasons for exclusion at the full-text review stage included: did not empirically assess professional competence outcomes, focusing only on foundational knowledge gains, not implemented in higher education, duplicate data, and irrelevant intervention or scope.

The PRISMA flow chart demonstrates how the exclusion criteria were employed in the current study (see Fig. 1 below).
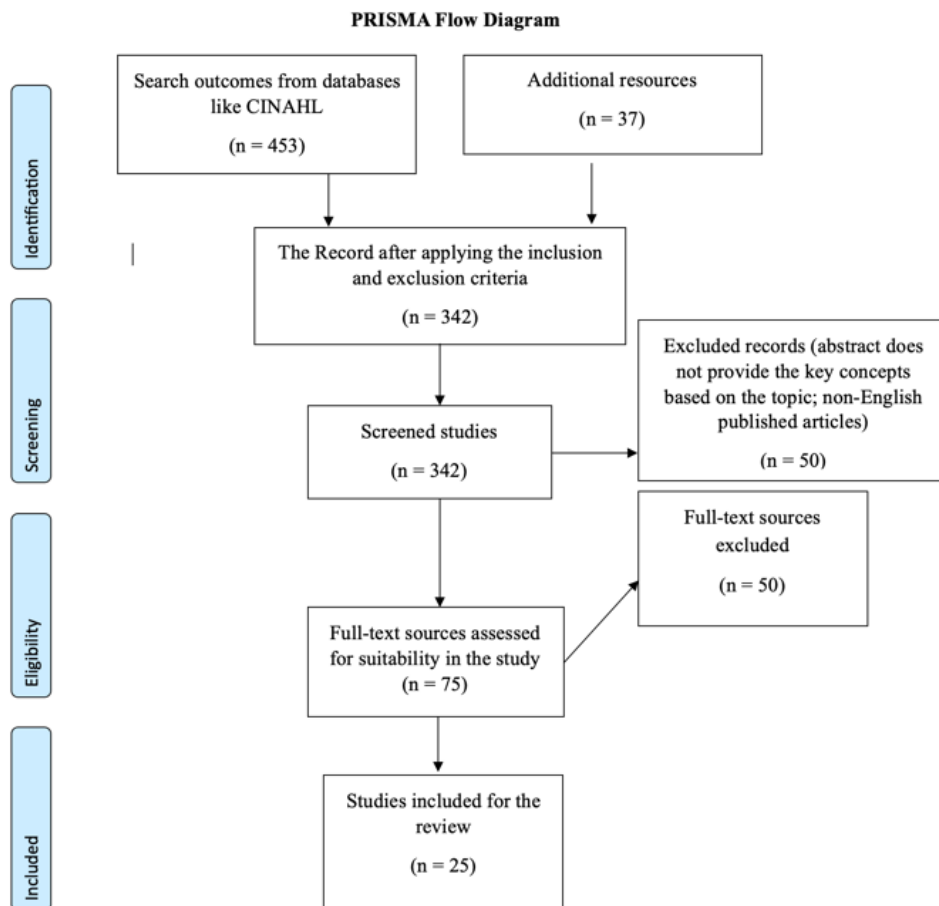

Figure 1. PRISMA flow chart indicating selection of articles for analysis.

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for fostering the integrated competencies demanded by modern professional practice (Boelt et al., 2022; Wisdom, 2015). Passive, transmission-focused instruction has been associated with superficial learning focused on short-term retention rather than deeper development of transferrable capabilities (Biggs et al., 2022; Bahgat, 2018; Uskov, Howlett, & Jain, 2015). This disconnect between conventional pedagogy and desired learning outcomes represents a key impetus driving increased interest in innovative, student-centered instructional models tailored to competence growth with regard to DIN EN ISO 9241-11 (Vindigni, 2023a; Vindigni, 2023b; Vindigni, 2023c; Vindigni, 2023d).

One major limitation highlighted in comparative international research is that nuanced differences in professional competence development across diverse university curricula remain underexplored (Wimmers & Mentkowski, 2016; Jackson & Wilton, 2016). For instance, while studies have shown that early childhood educators with Bachelor's degrees demonstrate greater expertise than those without university qualifications (Whitebook, 2003), few studies have examined variances in competence acquisition across academic programs utilizing different pedagogies, learning activities, and fieldwork components (Herrero et al., 2020; Bradshaw, Hultquist, and Hagler, 2019). Furthermore, research on competence development in higher education relies predominantly on students' self-assessments via surveys and reflections (Filho, Rogers, & Iyer-Raniga, 2018; Ling & Venesaar, 2015). However, self-reporting provides only one perspective on the complex, multifaceted processes underlying competence growth.

To address these gaps, expanded research utilizing longitudinal mixed-methods approaches is needed to better understand how professional knowledge, skills, and dispositions evolve across diverse university curricula and instructional contexts (Doull, 2022; Sanger & Gleason, 2020; Scharenberg et al., 2021). Combining self-assessments with more objective competence measures at multiple points can yield better insights into learning trajectories (Kee & Eraut, 2013; Clements & Sarama, 2012). Comparative studies evaluating emerging instructional models are also vital. In particular, adaptive and re-adaptive teaching approaches advancing technology, individualization, and experiential learning may hold unique potential to integrate skill development with conceptual learning in context (Widiati et al., 2023; Bakharia et al., 2016; Greer and McCalla, 2013). Investigating implementation and outcomes across disciplines can inform pedagogical improvements (Cain, 2018).

Specific research is warranted on professional education paths such as design, media, and communications degrees, where contemporary competence models emphasize creative thinking, digital literacy, and other capabilities beyond core conceptual knowledge (Spante et al., 2018). Comparative studies explicitly contrasting competence development across traditional lecture-based versus innovative adaptive and re-adaptive curricula in these applied contexts could illuminate specialized needs and guide pedagogical improvements tailored to these fields (Colchester et al., 2016). For instance, mapping how creative problem-solving skills evolve between student cohorts exposed to standardized versus personalized adaptive course sequences could inform specialized instructional reforms (Fleisch, 2018; Saltman & Means, 2018; Ferretti & Hiebert, 2017). Expanding comparative research on emerging instructional approaches using robust multidimensional methodologies can provide vital insights to guide reform efforts to optimize professional competence and capability development across diverse and specialized academic areas (Tse, Ki, & Shum, 2021; Furtak et al., 2012).

Theory and Investigator Triangulative Results

Competence Development along Educational Paths in International Comparative Studies

Comparative international research provides preliminary evidence that professional

competence development varies across different educational paths in the university sector (Lozano et al., 2017). In early childhood teacher education specifically, Whitebook (2003) found educators with Bachelor's degrees displayed more effective teaching practices and created higher quality learning environments than those without university qualifications. However, those with substantial field experience but non-degree credentials demonstrated similar competencies to degree holders, suggesting immersive experiential learning also plays a key role in developing professional capabilities (Wess et al., 2021). While this points to potential differences in competence outcomes between academic and vocational training paths, few large-scale studies have systematically examined variations in knowledge, skill, and disposition development across diverse higher education curricula and instructional approaches (Creasy, 2017; Hopkins, Provenzano, & Spencer, 2016; Huang, Li, & Zhou, 2016).

With the expansion of virtual and computer-based learning in higher education, some research has begun investigating differences in professional competence development between traditional face-to-face instruction and online environments (González-Lezcano, 2022; Potkanjak et al., 2016). Shaw-Battista et al. (2015) found that nurses who completed online vocational training performed similarly on care competency measures as peers in in-person programs. However, the development of communication skills was weaker (Fam et al., 2016). In teacher education, Olson & Werhan (2005) compared three cohorts who completed their degrees face-to-face, fully online, or via a hybrid model. Few differences emerged in teaching knowledge, though the online cohort scored lower in areas like lesson planning. This highlights the need for further comparative work examining professional competence acquisition across different educational delivery modes and blended designs, which adaptive and re-adaptive approaches may help strengthen (Rauner and Ahrens, 2022; Bauer et al., 2018; Zumbach et al., 2008).

Looking across teacher education programs more broadly, Jin (2017) conducted an impactful longitudinal study examining how completing student teaching abroad affected pre-service teachers' intercultural competence development compared to campus-based peers. Participants who undertook practicum experiences in international contexts showed significantly greater gains in intercultural awareness, attitudes towards diversity, and adaptation skills in cross-cultural environments compared to those completing domestic teaching placements (Wyatt & Dikilitaş, 2022; Cirocki, Madyarov, & Baecher, 2020; Barton & Hartwig, 2017). This provides compelling evidence for the value of immersive experiential learning in developing critical professional capabilities like cultural competence (Parry & Allison, 2019; Oxlea & Ilea, 2015; Kolb, Boyatzis, & Mainemelis, 2014; Kolb, 2014). However, an inherent limitation was that the study design did not isolate the unique effects of the international placement from other curricular variables, such as courses on multicultural education that may have differed between groups (Bennett, 2018; Shen, 2017; Erez et al., 2013).

While this research points to the potential benefits of intensive experiential learning, further comparative work is needed to systematically examine how specific curricular elements, pedagogies, and practical experiences impact competence development across various educational paths. Analytic designs that specifically control for potential confounding variables will provide clearer insights into the factors shaping professional competence growth.

In Germany, comprehensive longitudinal research tracing professional competence development across diverse higher education paths systematically and using multi-methods remains limited (Jeschke, Lindmeier, & Heinze, 2020; Riebenbauer & Stock, 2015; Klebl & Popescu-Willigmann, 2015; Schulze, Kanwischer, & Reudenbach, 2013). For instance, Heiskanen, Thidell, & Rodhe (2016) interviewed graduates from various academic fields and concluded their university education generally strengthened both subject-specific expertise and general competencies valued in the workplace, such as communication, critical

thinking, and problem-solving skills. However, the study did not quantitatively compare competence outcomes using objective measures across graduates from different disciplines or program types with varying curriculum models (Bartlett & Housden, 2023; Gosper & Ifenthaler, 2013; Marsh, 2009). It relied solely on self-reported assessments of perceived gains.

While this provides useful subjective perspectives, more robust comparative research is needed to elucidate knowledge, skill, and dispositional development variances across academic programs. Large-scale longitudinal designs that systematically track graduates' professional competence growth over time using multifaceted instruments, including tests, behavioral observations, and qualitative analyses, will provide clearer insights. Integrative mixed-methods approaches examining how specific pedagogies, learning activities, and practical experiences shape growth are also needed across diverse fields.

Self-assessment methods dominate

A key limitation in current professional competence development literature is the heavy reliance on student self-assessment surveys and reflections as the dominant evaluation methods (Choptiany et al., 2019; Lockeman et al., 2016). These subjective self-report measures provide only partial and potentially biased perspectives on multidimensional competence growth (Nikou & Economides, 2017; Blodyk, 2017).

In the German context specifically, self-assessments feature prominently across studies examining perceived competence gains in different academic disciplines and programs (Trautwein and Möller, 2016). Graduating students are typically asked to rate their improvement in analytic thinking, problem-solving, communication, teamwork, and practical skills (Filho et al., 2021; Mieg, 2019; Council of Europe, 2020; Arnold, 2015; Deißinger, 2015). However, perceptions may not align with objective competence levels. While these self-evaluations deliver useful snapshots of confidence, more holistic multi-method approaches combining self-assessments with tests, behavioral observations, and qualitative

performance analyses are needed to provide fuller perspectives on knowledge, skill, and disposition development along diverse educational paths (Holt et al., 2017). Overreliance on subjective self-ratings in isolation poses inherent limitations for understanding complex professional competence growth (Lantz-Deaton & Golubeva, 2020; Milan, 2015; Niemi & Nevgi, 2014).

The proliferation of online and blended learning also raises questions about impacts on identity and reflective skill development, competencies difficult to capture through traditional assessments (Lim et al., 2019; Philipsen et al., 2019; Vanslambrouck et al., 2018; McCutcheon et al., 2014).

Comparative studies of different modalities are needed to determine if remote environments provide conditions conducive to growth. Vabo, Slettebø, and Fossum (2022) found nursing students in an online program scored lower on professional identity measures than on-campus peers, though reflections revealed positive gains. Mixed-methods research with regard to the method triangulation approach on reflective capacities across learning contexts is limited but essential for holistically understanding professional competence acquisition in technology-enhanced higher education (Shen & Ho, 2020; Serrano et al., 2019; Flavin, 2016; Gregory & Lodge, 2015).

For instance, Grande (2022) used an extensive self-report inventory to compare perceived competence gains between graduating social and general pedagogy students across three universities. While this approach yielded a broad snapshot of students' self-evaluated improvements in problem-solving, social skills, and practical capabilities, the authors rightly note that these subjective ratings likely involve inherent positivity and social desirability biases. They cannot be directly equated with objectively measured capability levels.

The study's overreliance on self-assessments in isolation without triangulation provides insights limited in scope and vulnerable to distortion (Grande, 2022). While useful for gauging

confidence, overdependence on self-reported measures alone poses inherent validity limitations for developing holistic understandings of complex, multifaceted competence development processes (Grande, 2022; Gupta, 2020; Ryan & Deci, 2017). Mixed methods are needed to mitigate biases and construct fuller perspectives.

As online and blended models increase in higher education, an additional concern is whether remote environments provide conditions conducive to unbiased self-reflection on competence development. Vabo et al. (2022) found nursing students in a fully online program demonstrated positivity biases in self-assessments compared to peers in face-to-face settings when evaluating their clinical skills and decision-making. This highlights the need for triangulated virtual assessments to produce clearer insights into professional competence growth. Studies blending self-evaluations with performance data, psychometrics, and qualitative analysis may be especially vital in technology-enhanced learning contexts.

However, a few studies have adopted more multifaceted approaches that could serve as methodological models. For instance, Keane & Griffin (2018) triangulated student self-assessments of competence with teacher evaluations and grades when examining design students' skill development trajectories. Their analysis uncovered notable discrepancies between perceived and demonstrated proficiency levels in creative imagination, highlighting the limitations of self-reported measures alone. Similarly, Scharenberg et al. (2021) combined student self-assessments with teacher focus groups when mapping media arts students' competence growth over time.

This mixed-methods approach revealed gaps between students' confidence in their abilities and their actual skill mastery, further reinforcing the challenges of over-relying on self-perceptions (Raley, 2020). These studies underscore the need for holistic designs using multiple data sources to illuminate nuances and mitigate biases when examining professional competence progression along diverse educational paths.

Adaptive and Re-adaptive Approaches

Adaptive learning represents an emerging student-centered instructional approach that promotes intelligent technology and data analytics to provide highly personalized educational experiences tailored sensitively to each learner's evolving needs, competencies, and demonstrated progress in real-time (Liu et al., 2020; Sottilare & Schwarz, 2020; Natriello, 2019; Walkington, 2013). The core premise is a continuous modification of teaching based on ongoing assessment of students' knowledge development, skill levels, difficulties, misconceptions, and deepening conceptual understandings across a module or course (Singh et al., 2021; Attri, 2019; Kilpatrick, Joshi, & Wagner, 2019; Yilmaz, 2017).

By continuously analyzing individual responses to interactive assignments, embedded questions, simulations, and other digital activities, adaptive systems can rapidly identify knowledge gaps or mistaken beliefs as they arise in individuals or groups. Instructional strategies, feedback protocols, and scaffolding supports can then be adjusted dynamically to precisely target identified problem areas (Parsons, 2016).

While most current applications of adaptive learning focus on cognitive and skill development, emerging research also explores the potential to support professional identity growth and reflective skills. For instance, Scott-Muenter (2022) designed an adaptive e-portfolio system that leverages analytics to provide medical students with personalized feedback that guides critical reflection on experiences to strengthen their self-concept as clinicians. Other adaptive platforms scaffold reflective journaling and help shape professional narratives over time (Schwnedimann et al., 2018; Crossley & McNamare, 2016; Hyler & Hicks, 2014; Coulson & Harvey, 2013). As adaptive education expands, developers should strategically consider how adaptive elements could be leveraged for knowledge gains and to provide responsive support for the critical self-understanding, value clarification, and reflective

habits essential to professional identity development (Shum & Luckin, 2019; Belpaeme et al., 2018).

There are several fundamental characteristics of effective adaptive learning systems. First, there is ongoing measurement of student achievement, mastery, and developing understandings using varied embedded diagnostic assessments and checks for understanding built seamlessly into digital learning platforms (Mehta et al., 2021; Linzalone, Schiuma, & Ammirato, 2020; Johnson-Glenberg et al., 2016; Balzotti & McCool, 2015). Another characteristic is data-driven customization of sequencing concepts, learning resources, and activities based on analysis of performance patterns and comprehension indicators for each individual (Wan et al., 2021; Qi et al., 2019; Gamrat et al., 2014). Further, there are differentiated instructional techniques adapted responsively to students' pace, preferred modalities, and unfolding developmental needs (Sharaff, Sinha, & Bhatia, 2021; Uskov, Howlett, & Jain, 2021; Lavoué et al., 2017). The next characteristic is responsive digital content, such as targeted feedback messages, multimedia lessons, and contextual help, tailored to scaffold each student's evolving zone of proximal development (Maria et al., 2023; Uskov, Howlett, & Jain, 2022; Baneres et al., 2019). The last fundamental characteristic includes automated feedback loops that generate personalized recommendations for additional focus areas, practice opportunities, and enrichment resources precisely where they are needed for each learner (Noroozi & De Wever, 2023; Huang et al., 2023; Fudge & Ferebee, 2021).

In higher education, adaptive learning often manifests through interactive e-learning platforms that leverage multimedia, simulations, embedded quizzes, and customized study recommendations to promote active learning and continuously diagnose and respond to individuals' knowledge development (Bakharia et al., 2016; Fonseca, 2015). For instance, the Smart Sparrow (2023) platform provides real-time adaptive guidance and feedback during complex engineering design simulations based on analyzing students' decision-making (Wirtz et al., 2021; Mead et al., 2019; Yilmaz, 2017). Other systems like Knewton and Acrobatiq optimize the sequencing of video lessons, readings, quizzes, and activities based on each learner's unfolding mastery of concepts and skills (Mead et al., 2019; Dziuban et al., 2017). Adaptive learning aims to transform static content delivery into dynamic, personalized educational experiences optimized for each student.

Re-adaptive learning builds upon digitally-enabled adaptive instruction models by purposefully blending them with face-to-face active learning strategies, social interactions, and collaborative knowledge construction opportunities attuned to groups' interests and developmental trajectories (Zhong et al., 2020; Bower, Hedberg, and Kuswara, 2010). This hybrid approach combines intelligent technology systems that tailor content and activities to individuals with experiential learning scenarios, creative projects, and problem-solving challenges adapted to cohorts' needs (Cutrer et al., 2019; Kinshuk, 2016). Instructors assume an observant facilitation role, using learning analytics provided by the adaptive platform to continuously modify their in-person teaching approaches and group work with regard to the community-of-practice approach (Vindigni, 2023a; Vindigni, 2023b; Vindigni, 2023c; Vindigni, 2023d; Pappano, 2012). Well-designed re-adaptive courses move beyond merely complementing lectures with digital activities to fundamentally rethinking learning design around adaptive personalization synergistically integrated with active social knowledge building (Cortellessa et al., 2021).

Connection to learning theories

The core concepts and design principles underlying adaptive and re-adaptive learning approaches are strongly grounded in constructivist educational theories, which view knowledge development as an active, contextualized process of experiential meaning-making rather than the passive transmission of abstract information (Saba & Shearer, 2017; Midgley, 2014; Matheson, 2014; Piaget, 1970). Adaptivity embedded in responsive technology

allows instruction to be continuously tailored to build upon and respond sensitively to each learner's existing mental models, misconceptions, and developmental level to scaffold the active assimilation and accommodation processes by which individuals construct new understandings (Harasim, 2017; Walkington, 2013).

Similarly, social constructivism recognizes that collaborative knowledge building occurs interactively through shared hands-on discovery activities, discourse, and reflection tailored to each group's zone of proximal development (Harasim, 2017; Raphaely & Maroinova, 2013; Vygotsky & Cole, 1978). Re-adaptive blended models purposefully leverage these insights through in-person active learning scenarios adapted to support groups' evolving needs and readiness (Matthyssens, 2019; Hadjileontiadou, 2015).

Additionally, adaptive systems' personalized scaffolding and continuous diagnostic assessment capabilities may uniquely enhance professional competence, identity, and reflective skill development. Adaptive learning can provide granular insights into individuals' evolving mastery of profession-specific knowledge and skills, allowing responsive adjustments to learning pathways and interventions at pivotal points to solidify competence (Shirvani Boroujeni, 2018). Adaptive elements like tailored recommendations on self-reflective journaling or portfolio construction may also strengthen professional identity growth (Scott-Muenter, 2022). In addition, adaptive platforms could sequence metacognitive exercises and feedback to incrementally develop critical reflection abilities, fostering key competencies for continuous improvement and adaptation over one's career. In these ways, adaptive and re-adaptive models may powerfully augment conventional instruction to enrich professional competence, identity, and reflective capacities.

However, research on using adaptive learning specifically to develop professional competencies remains limited compared to applications in foundational disciplines like math and science. More work is needed to realize its

full potential. Kim (2018) designed an adaptive scaffolding system to provide pre-service teachers with tailored feedback on lesson plans to build pedagogical skills.

However, few similar applications exist tailored to other fields. Additionally, with minimal comparative studies, adaptive platforms have only recently begun incorporating elements targeting identity and reflective capacities. Carefully designed research identifying best practices across professions is essential to guide the development of adaptive systems that powerfully augment conventional instruction for holistic professional competence growth.

Additionally, the strong emphasis adaptive learning techniques place on metacognition, self-assessment, and self-regulated learning in their design aligns closely with research on effective learning strategies that distinguish deep, meaningful learning from passive surface approaches (Saluti, 2022; Entwistle, 2013; Vermunt, 2005). By requiring students to regularly self-monitor what they know, identify knowledge gaps or misconceptions, reflect on their learning processes, and seek necessary help, well-designed adaptive systems intentionally aim to build keystone habits like meaningful spaced practice, help-seeking behaviors, growth mindsets, and motivational and cognitive engagement that are all linked in the learning sciences to the durable acquisition of complex skills (Honigsfeld & Dove, 2020; Van Schalkwyk & Amato, 2015; Bjork, Dunlosky, & Kornell, 2013; Scales, 2012). Adaptive learning models embedded with ongoing metacognitive checkpoints and feedback aim to make typically implicit self-regulatory processes more explicit and visible for learners to strengthen (Schunk & Zimmermann, 2012; Peña-Ayala, 2012).

The core concept in adaptive learning approaches of a continuous cycle of building conceptual models, testing them through active experimentation, and revising them based on feedback mirrors Kolb's (1984) highly influential experiential learning cycle theory. Adaptive online platforms provide responsive spaces for learners to incrementally test provisional understandings through progressively more

challenging activities and receive personalized input and recommendations based on their performance that drive further refinement and integration of knowledge (Parsons et al., 2018).

As Kolb (1984; 2014) originally theorized, the essence of meaningful learning emerges through this iterative process of developing working conceptualizations, actively applying them in context, reflecting on the results, and adapting mental models based on the outcomes – exactly the cycle embedded within well-designed adaptive systems.

This experiential, constructivist foundation underlying adaptive learning approaches aligns well with professional competence development aims, which require deep internalization and mastery of knowledge through authentic applied practice rather than just theory transmission. The continuous cycles of experimentation, knowledge application in context, assessment, and responsive revision scaffolded by well-designed adaptive systems closely mirror the real-world process of developing expertise, incrementally strengthening understanding, skills, and reflective capabilities through progressive experience (Condon et al., 2016). This iterative, personalized model suggests a significant untapped potential for adaptive learning approaches to powerfully enhance professional competency growth compared to more static, one-size-fits-all transmissive instructional modes if thoughtfully implemented.

However, additional research is still needed to determine how specific adaptive learning design elements can be optimized to enrich professional competence, identity, and reflective capacities. Some current systems employ a narrow interpretation of adaptivity focused on automated content transmission rather than incorporating opportunities for authentic situated practice, reflection, and group collaboration. Carefully integrating personalized recommendations, metacognitive prompts, and social features could better support learners in actively co-constructing professional understandings and self-concepts (Pun, Curle, & Yuksel, 2022; Li & Xue, 2021; Ignagni, 2019).

Further comparative studies systematically examining the impacts of different adaptive feature combinations and implementations are essential to elucidate evidence-based best practices and realize the full transformative potential of adaptive learning to strengthen holistic professional education.

Evaluating professional competence

Evaluating the impact of adaptive teaching models on the development of professional competence presents multifaceted measurement challenges due to the complex, integrative nature of competence.

As contemporary competence models recognize, professional capability encompasses demonstrating knowledge and skills and underlying cognitive schema, motivational patterns, and ethical dispositions that effectively apply expertise in context (Frezza et al., 2018; Mulder, 2017). This demands assessment approaches aligned with this multidimensional conceptualization. Objective performance assessments are required to gauge applied skills and subjective techniques eliciting students' perceived competence, professional identity, reasoning patterns, and dispositions to form a holistic evaluation. Comparative studies on adaptive learning efficacy should utilize authentic, integrated tasks, psychometric surveys, qualitative self-evaluations, and behavioral observations to capture growth across professional competence's cognitive, skill-based, and affective facets (Chen et al., 2022; Fontaine et al., 2019; Midgley, 2014).

Knowledge, skills, and dispositions

Contemporary competence models recognize that professional capability requires conceptual knowledge and skill-based, self-regulatory, and affective facets (MacLaren et al., 2019; Velez-Morey, 2015; Liem, Lau, & Nie, 2008; Falco, 2008; Weinert, 2001). This demands multifaceted assessments.

Knowledge assessments like multiple-choice tests efficiently gauge retention but not transferable application or higher-order cognition (Thambusamy & Singh, 2021). Performance-based measures of skills in context

better evaluate intelligent applications but require time-intensive qualitative scoring.

Evaluating complex cognitive skills like critical thinking, clinical reasoning, and design thinking requires authentic, ill-structured challenges modeled on professional practice along with think-aloud protocols and rubrics rating competencies demonstrated (Moskal, Dziuban, and Picciano, 2023; Walkington et al., 2011). These aim to provide holistic perspectives on graceful knowledge integration.

Self-regulatory skills and motivation are best assessed through self-report surveys, learning diaries, and observational protocols that quantify behaviors like help-seeking, progress monitoring, and persistence when challenged (Rivers, Nakamura, & Vallance, 2022). Triangulating self-perceptions with direct measures enhances validity.

Professional identity and value development represent subjective constructs that require mixed self-reflections, psychometric attitudinal assessments, and portfolio or artifact analysis by trained raters (Nicolaidou, 2013; Ash & Clayton, 2004). Pre- and post-designs via cyber-physical systems can track growth. A comprehensive evaluation of the integrated knowledge, practical abilities, and dispositions defining professional competence requires a strategic combination of instruments and data sources. To produce credible insights, adaptive learning research must utilize multifaceted assessments aligned with contemporary competence definitions.

Studies in Media and Creative Domains

While research on adaptive learning has expanded across disciplines like science, math, and engineering, fewer studies have examined implementations and outcomes in the media and creative fields. However, the hands-on, digital skillsets central to these applied professions suggest a strong potential for adaptive teaching to support professional competence development.

In the digital design field, Yilmaz (2017) developed an adaptive e-learning system incorporating interactive simulations, quizzes, and multimedia content tailored to each learner's progress. The researchers evaluated the platform with 100 undergraduate graphic design students and found the adaptive instruction group demonstrated significantly greater gains in software skills and design thinking capabilities compared to students receiving non-adaptive online learning. Think-aloud interviews revealed adaptive features like personalized feedback that helped learners gain professional competencies (Ryoo & Winkelmann, 2021; Shute & Rahimi, 2017; Baylari & Montazer, 2009). This provides evidence for the value of adaptive courseware in contextualized, competence-based design education. Further research should explore impacts across full curricula and programs (France, 2022; Zhou et al., 2016; Phon-Amnuasuk, Au, & Omar, 2016; Nejdl et al., 2008).

These early studies demonstrate feasibility and promise, but scale-up research is needed. Comparisons of adaptive versus static teaching across full courses and programs would provide stronger evidence. Most current systems also take a narrow approach to adaptivity focused on content tailoring. Integrating adaptivity more holistically into activities, projects, peer interactions, and reflective journals could better support multifaceted professional growth (El-Adawy, 2022).

Overall, strategic research pairing emerging technologies like VR with adaptive learning principles could unlock innovative models for contextualized, personalized education in these fields (Vindigni, 2023d).

Critique

While the 25 studies in this review provide useful insights into adaptive learning approaches for professional competence development, several limitations are apparent when critically evaluating this body of literature.

Firstly, few studies utilized randomized controlled trial designs, with most employing weaker quasi-experimental, correlational, or purely qualitative methodologies such as Whitebook (2003) and Scharenberg et al. (2021). The lack of controlled comparisons makes it

difficult to definitively attribute observed competence gains to adaptive learning interventions rather than confounding variables (Liu et al., 2017; Shea et al., 2014; Cook & Steiner, 2010). Stronger causal validity would be achieved through randomized control groups and accounting for potential covariates (Cramer & Castro-Olivo, 2015).

Additionally, most studies had small sample sizes of under 100 participants, like the one by Olson & Werhan (2005), thus limiting generalizability. Larger scale, multi-site trials are needed to better understand how impacts may vary across contexts. The studies relied on self-report, perceptions, or course performance for competence measurement rather than psychometrically validated instruments. More objective competence assessments using mixed methods would strengthen validity. Furthermore, the interventions lacked detailed reporting and replication information in most cases. Adaptive learning was often vaguely defined without unpacking the key instructional design principles utilized or customization algorithms. This limits comparability across studies assessing dissimilarly configured platforms.

Finally, few studies examined long-term retention or transfer of competence gains outside the learning context. Additional longitudinal tracking would reveal valuable insights into lasting impacts on professional practice. Overall, expanded research using comparably robust, transparent designs and multidimensional assessments would enhance the quality and credibility of evidence on adaptive learning for competence acquisition.

Discussion

The past decade has seen increased interest in reimagining higher education teaching and learning to better foster the integrated knowledge, skills, and dispositions underlying professional competence. While traditional, passive lecture-based practices still dominate many university classrooms, scholars increasingly recognize the need for more enriched, active, and social models aligned with leading learning sciences theories (Feldman, 2019; Lin and Spector, 2017; Esmonde and Booker, 2016; Baeten, 2010). Adaptive and re-adaptive blended approaches represent promising student-centered innovations to bridge this gap by using technology and learning analytics to provide personalized instruction tailored to evolving needs.

However, current literature also reveals significant limitations and open questions. Comparative research examining professional competence development across educational paths remains limited, hampering efforts to identify effective curriculum models (Vindigni, 2023a; Mulder, 2017; Richard, 2010). This is compounded by over-reliance on student self-report for assessment, which risks inflated perspectives on growth. Meanwhile, empirical studies evaluating adaptive learning specifically for professional education are still emerging. Yet early results highlight the untapped potential.

Conclusion

Intentional use of adaptive elements could allow transformative pedagogies leveraging experiential learning, personal meaning-making, and social construction of knowledge while retaining needed structure and direction (Bakharia, 2016). Comparative and longitudinal studies on the integrative implementation of adaptive learning could catalyze wider reform.

Advantages of Adaptive and Re-adaptive Approaches

Adaptive and re-adaptive learning models offer several advantages that make them promising avenues for enhancing professional competence acquisition compared to one-size-fits-all didactic practices.

Firstly, adaptivity enables greater personalization and scaffolding tailored to individuals' evolving zone of proximal development by providing a transparent channel for continuous diagnostic assessment (Csapó & Molnár, 2019; Walkington, 2013; Leighton & Gierl, 2007). Targeted feedback and exercises can build precisely on

current skill levels without overloading (Confrey et al. 2017). This precision scaffolding facilitates active assimilative learning and the gradual internalization of complex competencies.

Secondly, adaptive systems intrinsically foster reflective metacognitive habits like goal-setting, progress monitoring, and help-seeking, enhancing self-regulated professional learning (Collins et al., 2018; Bannert, Reimann, & Sonnenberg, 2014). Features like interactive concept maps transparently track and visualize growth.

Thirdly, iterative cycles of experimentation, application, and model revision embedded in adaptive platforms mirror authentic processes of competence development, facilitating transfer (Parsons et al., 2018; Agustianto et al., 2016). Integrating re-adaptive collaborative projects amplifies real-world connections.

Fourthly, intelligent analytics provide instructors with timely insights into cohort progress to continually improve teaching and ensure alignment with learning outcomes (Cuterer et al., 2017; Bakharia et al., 2016). Faculty can target interventions toward frequently misinterpreted concepts.

Finally, carefully implementing adaptive learning enables richer educational experiences by blending self-directed online learning with interactive group discovery while retaining the benefits of social knowledge construction. This fulfills a more holistic vision of learning for professional competence than pure lecture or technology-mediated models.

Recommendations for Implementation in Creative Fields

Realizing the promise of adaptive learning to transform professional education requires careful, strategic implementation attuned to each discipline's specialized needs and the emerging capabilities of adaptive technologies. Based on the current research literature, the following recommendations can guide the effective integration of adaptive teaching in creative fields like design and media.

Instructional design:

- Co-developing adaptive platforms between educators, researchers, and designers iteratively from the ground up over simple retrofitting of existing systems to maximize relevance.

- Aligning adaptivity to curricular content and learning activities, collaborations, assessments, and reflective exercises for comprehensive integration.

- Modeling adaptive assignments and simulations on authentic professional tasks and processes to provide situated learning in context.

- Using adaptive features like student tracking, personalized recommendations, and visual data representations to reinforce metacognitive competencies.

Technology:

- Exploring immersive adaptive simulations leveraging AR, XR, and VR to foster experiential learning and representational competence with digital media.

- Curating multimedia content libraries spanning texts, videos, visualizations, and simulations tailored to course topics as rich adaptive resources.

- Developing smart recommendation engines that connect learners to personalize resources, mentors, and peer collaborators that meet self-identified needs.

Faculty development management:

- Providing extensive training for educators on designing and facilitating learning experiences that adaptive platforms enable rather than simply providing technology tools.

- Supporting the transition of instructors' roles from lecturing facts to guiding learning, modeling competencies, and providing personalized feedback within adaptive environments.

- Creating faculty learning communities to advance adaptive teaching practices tailored for program contexts collaboratively.

Targeting professional education aims and thoughtfully integrating adaptive design principles holistically into curricular elements, learning environments, faculty training, and ed-tech tools can unlock transformative new models for enriching media and creative competence development.

Limitations and Future Research Needed

While this review highlights the promising potential of adaptive learning, significant additional research is needed to guide effective implementations. Most existing studies focus narrowly on adaptive platforms rather than integrations into broader teaching and learning systems (Sun, Shen, and Lin, 2020; Montebello, 2017; Bakharia et al., 2016; Michalski, 2012). Holistic research examining how adaptive elements can strengthen other pedagogical innovations is crucial for impact. Additionally, few rigorous comparative studies isolate the unique benefits of adaptive designs from other variables. Large-scale, multi-year studies tracking long-term competence development using consistent mixed-methods measurements would build much-needed evidence.

Another limitation is the overwhelming focus on cognitive outcomes rather than identity, self-efficacy, and other affective facets essential to professional competence. Research on adaptive learning often utilizes narrowly standardized tests rather than authentic, integrated tasks (Kurni et al., 2023; Guralnick, Auer, and Poce, 2022; Baeten, 2010). Developing efficient, validated measures for broader competencies is critical to fully evaluating adaptive models. Finally, comparative research across fields can help determine the best adaptive designs for different professional education contexts rather than a one-size-fits-all approach.

In conclusion, this review synthesizes current literature, which, while still emergent, suggests significant promise for adaptive teaching to transform higher education for holistic professional competence development if thoughtfully implemented. As Mulder (2017) concluded, "The challenge is now to develop comprehensive instructional models that make optimal use of the opportunities adaptive e-learning technologies offer to improve students' competence development in higher education." Continued research building evidence-based adaptive designs through comparative studies, longitudinal tracking, and multidimensional measurements can help unlock this transformative potential across disciplines.

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Conflict of interests

No conflict of interest.

References

Agustianto, K., Permanasari, A.E., Kusumawardani, S.S., & Hidayah, I. (2016). Design adaptive learning system using metacognitive strategy path for learning in classroom and intelligent tutoring systems. *Nucleation and Atmospheric Aerosols.* https://doi.org/10.1063/1.4958507

Arnold, R. (2015). *Bildung nach Bologna!: Die Anregungen der europäischen Hochschulreform.* Springer-Verlag.

Ash, S.L., & Clayton, P.H. (2004). The Articulated Learning: an approach to guided reflection and assessment. *Innovative Higher Education, 29*(2), 137–154. https://doi.org/10.1023/b:ihie.0000048795.84634.4a

Attri, R.K. (2019). *The models of skill acquisition and expertise development: A Quick Reference of Summaries.* Speed To Proficiency Research: S2Pro©.

Augstein, M., Herder, E., & Wörndl, W. (2023). *Personalized Human-Computer Interaction*. Walter de Gruyter GmbH & Co KG.

Baeten, M., Kyndt, E., Struyven, K., & Dochy, F. (2010). Using student-centred learning environments to stimulate deep approaches to learning: Factors encouraging or discouraging their effectiveness. *Educational Research Review*, *5*(3), 243–260. https://doi.org/10.1016/j.edurev.2010.06.001

Baguley, M., Danaher, P.A., Davies, A., De George-Walker, L., Jones, J.K., Matthews, K.J., Arden, C. (2014). Learning and teaching styles. In *Palgrave Macmillan UK eBooks* (pp. 98–110). https://doi.org/10.1057/9781137392848_8

Bahgat, M.M. (2018). *FIRST Framework, 5 Domains 15 principles: Design & Facilitate Active Deep Learner eXperience (Volume 1) 1st Edition*. Mohamed M. Bahgat.

Bakharia, A., Corrin, L., De Barba, P., Kennedy, G., Gasevic, D., Mulder, R. A., Lockyer, L. (2016). A conceptual framework linking learning design with learning analytics. *Proceedings of the Sixth International Conference on Learning Analytics & Knowledge*. https://doi.org/10.1145/2883851.2883944

Balzotti, J., & McCool, L. B. (2015). Using digital learning platforms to extend the flipped classroom. *Business and Professional Communication Quarterly*, *79*(1), 68–80. https://doi.org/10.1177/2329490615606497

Baneres, D., Rodríguez, M. E., & Guerrero-Roldán, A. E. (2019). *Engineering Data-Driven Adaptive trust-based e-Assessment systems: Challenges and Infrastructure Solutions*. Springer Nature.

Bannert, M., Reimann, P., & Sonnenberg, C. (2014). Process mining techniques for analysing patterns and strategies in students' self-regulated learning. *Metacognition and Learning*, *9*(2), 161–185. https://doi.org/10.1007/s11409-013-9107-6

Baroncelli, S., Farneti, R., Horga, I., & Vanhoonacker, S. (2013). *Teaching and Learning the European Union: Traditional and Innovative Methods*. Springer Science & Business Media.

Bartlett, J., & Housden, E. (2023). *Developing an outstanding curriculum*. Taylor & Francis.

Barton, G., & Hartwig, K. (2017). *Professional learning in the work place for international students: Exploring Theory and Practice*. Springer.

Bauer, J., Gartmeier, M., Wiesbeck, A. B., Moeller, G. E., Karsten, G., Fischer, M. R., & Prenzel, M. (2018). Differential learning gains in professional conversation training: A latent profile analysis of competence acquisition in teacher-parent and physician-patient communication. *Learning and Individual Differences*, *61*, 1–10. https://doi.org/10.1016/j.lindif.2017.11.002

Baylari, A., & Montazer, G. A. (2009). Design a personalized e-learning system based on item response theory and artificial neural network approach. *Expert Systems With Applications*, *36*(4), 8013–8021. https://doi.org/10.1016/j.eswa.2008.10.080

Belpaeme, T., Kennedy, J., Ramachandran, A., Scassellati, B., & Tanaka, F. (2018). Social robots for education: A review. *Science Robotics*, *3*(21). https://doi.org/10.1126/scirobotics.aat5954

Bennett, C. (2018). *Comprehensive Multicultural Education: theory and practice*. Retrieved from http://ci.nii.ac.jp/ncid/BA61045786

Biggs, J., Tang, C. and Kennedy, G., 2022. *Teaching for quality learning at university* (5th ed.). London: McGraw-Hill Education (UK).

Bjork, R. A., Dunlosky, J., & Kornell, N. (2013). Self-Regulated Learning: Beliefs, techniques, and illusions. *Annual Review of Psychology*, *64*(1), 417–444. https://doi.org/10.1146/annurev-psych-113011-143823

Boelt, A. M., Kolmos, A., & Holgaard, J. E. (2022). Literature review of students' perceptions of generic competence development in problem-based learning in engineering education. *European Journal of Engineering Education*, *47*(6), 1399–1420. https://doi.org/10.1080/03043797.2022.2074819

Bower, M., Hedberg, J.G. and Kuswara, A., (2010). A framework for Web 2.0 learning

design. *Educational Media International*, 47(3), pp.177-198.

Bradshaw, M. J., Hultquist, B. L., & Hagler, D. (2019). *Innovative teaching strategies in nursing and related health professions.* Jones & Bartlett Learning.

Cain, T. (2018). *Becoming a Research-Informed school: Why? What? How?* Routledge.

Chen, C., Hung, P., Eğrioğlu, E., & Hsiao, K. (2022). *Deep learning in Adaptive Learning: Educational Behavior and Strategy.* Frontiers Media SA.

Choptiany, J. M. H., Phillips, S., Graeub, B. E., Colozza, D., Settle, W. H., Herren, B., & Batello, C. (2016). SHARP: integrating a traditional survey with participatory self-evaluation and learning for climate change resilience assessment. *Climate and Development*, *9*(6), 505–517. https://doi.org/10.1080/17565529.2016.1174661

Cirocki, A., Madyarov, I., & Baecher, L. (2020). *Current perspectives on the TESOL Practicum: Cases from around the Globe.* Springer Nature.

Clegg, S., Tan, J., & Saeidi, S. (2002). Reflecting or acting? Reflective practice and continuing professional development in higher education. *Reflective Practice*, *3*(1), 131–146. https://doi.org/10.1080/14623940220129924

Clements, D. H., & Sarama, J. (2012). *Hypothetical learning trajectories: A Special Issue of Mathematical Thinking and Learning.* Routledge.

Colchester, K., Hagras, H., Alghazzawi, D., & Aldabbagh, G. (2016). A Survey of Artificial Intelligence Techniques Employed for Adaptive Educational Systems within E-Learning Platforms. *Journal of Artificial Intelligence and Soft Computing Research*, *7*(1), 47–64. https://doi.org/10.1515/jaiscr-2017-0004

Collins, A., Brown, J. S., & Newman, S. E. (2018). Cognitive Apprenticeship: Teaching the crafts of reading, writing, and mathematics. In *Routledge eBooks* (pp. 453–494). https://doi.org/10.4324/9781315044408-14

Condon, W., Iverson, E., Manduca, C. A., Rutz, C., Willett, G., & Huber, M. T. (2016). *Faculty Development and Student Learning: Assessing the connections.* Retrieved from https://muse.jhu.edu/book/43108

Confrey, J., Gianopulos, G., McGowan, W., Shah, M., & Belcher, M. (2017). Scaffolding learner-centered curricular coherence using learning maps and diagnostic assessments designed around mathematics learning trajectories. *Zdm – Mathematics Education*, *49*(5), 717–734. https://doi.org/10.1007/s11858-017-0869-1

Cook, R. E., Klein, M. D., & Chen, D. (2019). *Adapting Early Childhood Curricula for Children with Special Needs.* Pearson.

Cortellessa, G., De Benedictis, R., Fracasso, F., Orlandini, A., Umbrico, A., & Cesta, A. (2021). AI and robotics to help older adults: Revisiting projects in search of lessons learned. *Paladyn*, *12*(1), 356–378. https://doi.org/10.1515/pjbr-2021-0025

Coulson, D., & Harvey, M. (2013). Scaffolding student reflection for experience-based learning: a framework. *Teaching in Higher Education*, *18*(4), 401–413. https://doi.org/10.1080/13562517.2012.752726

Cramer, K., & Castro-Olivo, S. M. (2015). Effects of a culturally Adapted Social-Emotional Learning Intervention Program on students' Mental health. *Contemporary School Psychology*, *20*(2), 118–129. https://doi.org/10.1007/s40688-015-0057-7

Creasy, R. (2017). *The taming of education: Evaluating Contemporary Approaches to Learning and Teaching.* Springer.

Crossley, S. A., & McNamara, D. S. (2016). *Adaptive Educational Technologies for Literacy instruction.* Routledge.

Csapó, B., & Molnár, G. (2019). Online diagnostic assessment in support of personalized teaching and learning: the eDIA system. *Frontiers in Psychology*, *10*. https://doi.org/10.3389/fpsyg.2019.01522

Cutrer, W. B., Miller, B. M., Pusic, M., Mejicano, G. C., Mangrulkar, R. S., Gruppen, L. D., Moore, D. E. (2017). Fostering the development of

master adaptive learners. *Academic Medicine*, *92*(1), 70–75. https://doi.org/10.1097/acm.0000000000001323

Cutrer, W., Pusic, M., Gruppen, L. D., Hammoud, M. M., & Santen, S. A. (2019). *The master adaptive learner*. Elsevier Health Sciences.

Darby, F., & Lang, J. M. (2019). *Small teaching online: Applying Learning Science in Online Classes*. John Wiley & Sons.

De Pablos Patricia, O., Lytras, M. D., & Zhang, X. (2020). *IT and the Development of Digital Skills and Competences in Education*. IGI Global.

Deardorff, D. K., & Arasaratnam-Smith, L. A. (2017). *Intercultural competence in higher education: International Approaches, Assessment and Application*.

Deeley, S. (2014). *Critical Perspectives on Service-Learning in Higher Education*. Springer.

Deißinger, T. (2015). International education policy: Its influence on the conception of VET and the VET system in Germany. *Research in Comparative and International Education*, *10*(4), 607–621. https://doi.org/10.1177/1745499915613248

Doull, K. (2022). *Teaching a diverse primary curriculum*. SAGE.

Dziuban, C. D., Moskal, P., Johnson, C., & Evans, D. (2017). Adaptive Learning: A Tale of Two Contexts. *Current Issues in Emerging eLearning*, *4*(1), 3. Retrieved from https://scholarworks.umb.edu/cgi/viewcontent.cgi?article=1038&context=ciee

El-Adawy, S., Huynh, T., Kustusch, M. B., & Sayre, E. C. (2022). Context interactions and physics faculty's professional development: Case study. *Physical Review Physics Education Research*, *18*(2), 020104. https://doi.org/10.1103/physrevphyseducres.18.020104

Entwistle, N. J. (2013). *Styles of learning and teaching: An Integrated Outline of Educational Psychology for Students, Teachers and Lecturers*. Routledge.

Erez, M., Lisak, A., Harush, R., Glikson, E., Nouri, R., & Shokef, E. (2013). Going global: Developing management students' cultural intelligence and global identity in culturally diverse virtual teams. *Academy of Management Learning and Education*, *12*(3), 330–355. https://doi.org/10.5465/amle.2012.0200

Esmonde, I., & Booker, A. N. (2016). *Power and privilege in the learning sciences: Critical and Sociocultural Theories of Learning*. Taylor & Francis.

Europe, C. O. (2020). *Common European Framework of Reference for Languages: Learning, Teaching, assessment: Companion volume*. Council of Europe.

Falco, L. D. (2008). *&qout;Skill-Builders &qout;: Enhancing Middle School Students' Self-efficacy and Adaptive Learning Strategies in Mathematics*.

Fam, D., Palmer, J., Riedy, C., & Mitchell, C. (2016). *Transdisciplinary research and practice for sustainability outcomes*. Routledge.

Feldman. (2019). *Learning Science: theory, research, and practice*. McGraw Hill Professional.

Ferretti, R. P., & Hiebert, J. (2017). *Teachers, teaching, and reform: Perspectives on Efforts to Improve Educational Outcomes*. Routledge.

Filho, W. L., Rogers, J., & Iyer-Raniga, U. (2018). *Sustainable development research in the Asia-Pacific region: Education, Cities, Infrastructure and Buildings*. Springer.

Filho, W. L., Salvia, A. L., Brandli, L., Azeiteiro, U. M., & Pretorius, R. (2021). *Universities, Sustainability and Society: Supporting the implementation of the sustainable development goals*. Springer Nature.

Flavin, M. (2016). Technology-enhanced learning and higher education. *Oxford Review of Economic Policy*, *32*(4), 632–645. https://doi.org/10.1093/oxrep/grw028

Fleisch, B. (2018). *The education triple cocktail: System-wide instructional reform in South Africa*. UCT Press / Juta and Company (Pty) Ltd.

Fonseca, D. (2015). *Handbook of Research on Applied E-Learning in Engineering and Architecture Education*. IGI Global.

Fontaine, G., Cossette, S., Maheu-Cadotte, M., Mailhot, T., Deschênes, M., Mathieu-Dupuis,

G., Dubé, V. (2019). Efficacy of adaptive e-learning for health professionals and students: a systematic review and meta-analysis. *BMJ Open*, *9*(8), e025252. https://doi.org/10.1136/bmjopen-2018-025252

France, P. E. (2022). *Reclaiming personalized learning: A Pedagogy for Restoring Equity and Humanity in Our Classrooms*. Corwin Press.

Frezza, S., Daniels, M., Pears, A., Cajander, Å., Kann, V., Kapoor, A., Wallace, C. (2018). Modelling competencies for computing education beyond 2020: a research based approach to defining competencies in the computing disciplines. *Proceedings Companion of the 23rd Annual ACM Conference on Innovation and Technology in Computer Science Education*, 148–174. https://doi.org/10.1145/3293881.3295782

Fudge, T. P., & Ferebee, S. S. (2021). *Curriculum development and online instruction for the 21st century*. IGI Global.

Furtak, E. M., Seidel, T., Iverson, H. L., & Briggs, D. C. (2012). Experimental and Quasi-Experimental studies of Inquiry-Based science teaching. *Review of Educational Research*, *82*(3), 300–329. https://doi.org/10.3102/0034654312457206

Gamrat, C., Zimmerman, H. T., Dudek, J., & Peck, K. L. (2014). Personalized workplace learning: An exploratory study on digital badging within a teacher professional development program. *British Journal of Educational Technology*, *45*(6), 1136–1148. https://doi.org/10.1111/bjet.12200

González-Lezcano, R. A. (2022). *Advancing STEM education and innovation in a time of distance learning*. IGI Global.

Gosper, M., & Ifenthaler, D. (2013). *Curriculum models for the 21st century: Using Learning Technologies in Higher Education*.

Grande, R. a. N., Berdida, D. J. E., Susanto, T., Khan, A. A., Waelveerakup, W., & Saad, Z. (2022). Nursing competency inventory and professional competence of graduating students in six Asian countries: A cross-sectional study. *Nurse Education Today*, *116*, 105470. https://doi.org/10.1016/j.nedt.2022.105470

Greer, J. E., & McCalla, G. I. (2013). *Student Modelling: The Key to Individualized Knowledge-Based instruction*. Springer Science & Business Media.

Gregory, M., & Lodge, J. M. (2015). Academic workload: the silent barrier to the implementation of technology-enhanced learning strategies in higher education. *Distance Education*, *36*(2), 210–230. https://doi.org/10.1080/01587919.2015.1055056

Gupta, I. (2020). *Competency Mapping and Assessment Manual - User Guide*.

Guralnick, D., Auer, M. E., & Poce, A. (2022). *Innovative Approaches to Technology-Enhanced Learning for the workplace and Higher education: Proceedings of 'The Learning Ideas Conference' 2022*. Springer Nature.

Hadjileontiadou, S. J. (2015). *Fuzzy Logic-Based modeling in collaborative and blended learning*. IGI Global.

Harasim, L. (2017). *Learning theory and online technologies*. Taylor & Francis.

Heiskanen, E., Thidell, Å., & Rodhe, H. (2016). Educating sustainability change agents: the importance of practical skills and experience. *Journal of Cleaner Production*, *123*, 218–226. https://doi.org/10.1016/j.jclepro.2015.11.063

Herrero, Á., Cambra, C., Urda, D., Sedano, J., Quintián, H., & Corchado, E. (2020). *The 11th International Conference on EUropean Transnational Educational (ICEUTE 2020)*. Springer Nature.

Holt, N. L., Neely, K. C., Slater, L., Camiré, M., Côté, J., Fraser-Thomas, J., Tamminen, K. A. (2016). A grounded theory of positive youth development through sport based on results from a qualitative meta-study. *International Review of Sport and Exercise Psychology*, *10*(1), 1–49. https://doi.org/10.1080/1750984x.2016.1180704

Honigsfeld, A., & Dove, M. G. (2020). *Co-Teaching for English learners: Evidence-based Practices and Research-Informed Outcomes*. IAP.

Hopkins, M., Provenzano, A. M., & Spencer, M. S. (2016). Benefits, challenges, characteristics and instructional approaches in an El Sistema inspired after-school string program developed as a university–school partnership in the United States. *International Journal of Music Education*, *35*(2), 239–258. https://doi.org/10.1177/0255761416659509

Huang, R., Li, B., & Zhou, L. (2016). Information literacy instruction in Chinese universities: MOOCs versus the traditional approach. *Library Hi Tech*, *34*(2), 286–300. https://doi.org/10.1108/lht-02-2016-0013

Huang, Y., Syed-Abdullah, S.I.S., Zulkifli, N.N. and Ghazali, N., 2023. Blended learning as an optimal strategy for teacher's professional development: systematic literature review. *Educational Administration: Theory and Practice*, 29(2).

Hyler, J., & Hicks, T. (2014). *Create, Compose, Connect!: Reading, Writing, and Learning with Digital Tools*. Routledge.

Ignagni, A. R. (2019). *Stories of collaborative inquiry: resistance and negotiation in the social construction of educator knowledge*. Toronto: University of Toronto (Canada).

Jaafar, I., & Pedersen, J. M. (2021). *Emerging realities and the future of technology in the classroom*. IGI Global.

Jackson, D., & Wilton, N. (2016). Developing career management competencies among undergraduates and the role of work-integrated learning. *Teaching in Higher Education*, *21*(3), 266–286. https://doi.org/10.1080/13562517.2015.1136281

Jeschke, C., Lindmeier, A., & Heinze, A. (2020). Vom Wissen zum Handeln: Vermittelt die Kompetenz zur Unterrichtsreflexion zwischen mathematischem Professionswissen und der Kompetenz zum Handeln im Mathematikunterricht? Eine Mediationsanalyse. *Journal Für Mathematik-didaktik*, *42*(1), 159–186. https://doi.org/10.1007/s13138-020-00171-2

Johnson-Glenberg, M. C., Megowan-Romanowicz, C., Birchfield, D., & Savio-Ramos, C. (2016). Effects of embodied learning and digital platform on the retention of physics content: Centripetal force. *Frontiers in Psychology*, *7*. https://doi.org/10.3389/fpsyg.2016.01819

Keane, L., & Griffin, C. (2018). Assessing self-assessment: can age and prior literacy attainment predict the accuracy of children's self-assessments in literacy? *Irish Educational Studies*, *37*(1), 127–147. https://doi.org/10.1080/03323315.2018.1449001

Kee, A. M., & Eraut, M. (2013). *Learning trajectories, innovation and identity for professional development*. Springer.

Kilpatrick, D. A., Joshi, R. M., & Wagner, R. K. (2019). *Reading development and difficulties: Bridging the Gap Between Research and Practice*. Springer Nature.

Kim, D. (2018). A framework for implementing OER-Based lesson design activities for Pre-Service teachers. *The International Review of Research in Open and Distributed Learning*, *19*(4). https://doi.org/10.19173/irrodl.v19i4.3394

Kim, Y., Jung, Y., & Tracy-Ventura, N. (2017). Implementation of a localized Task-Based course in an EFL context: A study of students' evolving perceptions. *TESOL Quarterly*, *51*(3), 632–660. https://doi.org/10.1002/tesq.381

Kinshuk. (2016). *Designing adaptive and personalized learning environments*. Routledge.

Klebl, M., & Popescu-Willigmann, S. (2015). *Handbuch Bildungsplanung: Ziele und Inhalte beruflicher Bildung auf unterrichtl., organisationaler & politischer Ebene*. wbv Media GmbH & Company KG.

Kolb, D. A. (1984). *Experience as the source of learning and development prentice-hall*. Englewood Cliffs: Prentice Hall.

Kolb, D. A. (2014). *Experiential learning: Experience as the Source of Learning and Development*. FT Press.

Kolb, D. A., Boyatzis, R. E., & Mainemelis, C. (2014). Experiential Learning Theory: previous research and new directions. In *Routledge eBooks*

(pp. 227–248). https://doi.org/10.4324/9781410605986-9

Köseoğlu, S., Veletsianos, G., & Rowell, C. (2023). *Critical digital pedagogy in higher education.* Athabasca University Press.

Kurni, M., Mohammed, M. S., & G, S. K. (2023). *A beginner's guide to introduce artificial intelligence in teaching and learning.* Springer Nature.

Lantz-Deaton, C., & Golubeva, I. (2020). *Intercultural competence for college and university students: A Global Guide for Employability and Social Change.* Springer Nature.

Lavoué, É., Drachsler, H., Verbert, K., Broisin, J., & Pérez-Sanagustín, M. (2017). *Data driven approaches in digital education: 12th European Conference on Technology Enhanced Learning, EC-TEL 2017, Tallinn, Estonia, September 12–15, 2017, Proceedings.* Springer.

Leighton, J., & Gierl, M. (2007). *Cognitive Diagnostic Assessment for Education: Theory and Applications.* Cambridge University Press.

Li, J., & Xue, E. (2021). *Creating World-Class universities in China: Ideas, Policies, and Efforts.* Springer Nature.

Liem, G. a. D., Lau, S., & Nie, Y. (2008). The role of self-efficacy, task value, and achievement goals in predicting learning strategies, task disengagement, peer relationship, and achievement outcome. *Contemporary Educational Psychology*, *33*(4), 486–512. https://doi.org/10.1016/j.cedpsych.2007.08.00 1

Lim, D. H., Morris, M. L., & Kupritz, V. W. (2019). Online vs. Blended Learning: Differences in Instructional Outcomes and Learner Satisfaction. *Online Learning, 11*(2). https://doi.org/10.24059/olj.v11i2.1725

Lin, L., & Spector, J. M. (2017). *The Sciences of Learning and instructional design: Constructive Articulation Between Communities.* Routledge.

Ling, H., & Venesaar, U. (2015). Enhancing entrepreneurship education of engineering students for increasing their metacognitive abilities: analysis of students' self-assessments.

The Engineering Economics, *26*(3). https://doi.org/10.5755/j01.ee.26.3.5283

Linzalone, R., Schiuma, G., & Ammirato, S. (2020). Connecting universities with entrepreneurship through digital learning platform: functional requirements and education-based knowledge exchange activities. *International Journal of Entrepreneurial Behaviour & Research*, *26*(7), 1525–1545. https://doi.org/10.1108/ijebr-07-2019-0434

Liu, L., Jiang, H., He, P., Chen, W., Liu, X., Gao, J., & Han, J. (2020). On the Variance of the Adaptive Learning Rate and Beyond. *International Conference on Learning Representations*. Retrieved from https://openreview.net/pdf?id=rkgz2aEKDr

Liu, M., McKelroy, E., Corliss, S. B., & Carrigan, J. E. (2017). Investigating the effect of an adaptive learning intervention on students' learning. *Educational Technology Research and Development*, *65*(6), 1605–1625. https://doi.org/10.1007/s11423-017-9542-1

Lockeman, K., Dow, A., DiazGranados, D., McNeilly, D. P., Nickol, D., Koehn, M. L., & Knab, M. (2016). Refinement of the IPEC Competency Self-Assessment survey: Results from a multi-institutional study. *Journal of Interprofessional Care*, *30*(6), 726–731. https://doi.org/10.1080/13561820.2016.12209 28

Lozano, R., Merrill, M. Y., Sammalisto, K., Ceulemans, K., & Lozano, F. J. (2017a). Connecting Competences and Pedagogical Approaches for Sustainable Development in Higher Education: A Literature Review and Framework proposal. *Sustainability*, *9*(10), 1889. https://doi.org/10.3390/su9101889

Lozano, R., Merrill, M. Y., Sammalisto, K., Ceulemans, K., & Lozano, F. J. (2017b). Connecting Competences and Pedagogical Approaches for Sustainable Development in Higher Education: A Literature Review and Framework proposal. *Sustainability*, *9*(10), 1889. https://doi.org/10.3390/su9101889

Maria, L. A., Wenrich, R., Axelsson, C., & Kröger, W. (2023). *Changing time - shaping world:*

Changemakers in Arts & Education. transcript Verlag.

Marsh, C. J. (2009). *Key concepts for understanding curriculum.* Taylor & Francis.

Matheson, D. (2014). *An introduction to the study of education.* Routledge.

Matthyssens, P. (2019). Reconceptualizing value innovation for Industry 4.0 and the Industrial Internet of Things. *Journal of Business & Industrial Marketing,* *34*(6), 1203–1209. https://doi.org/10.1108/jbim-11-2018-0348

McCutcheon, K., Lohan, M., Traynor, M., & Martin, D. (2014). A systematic review evaluating the impact of online or blended learning vs. face-to-face learning of clinical skills in undergraduate nurse education. *Journal of Advanced Nursing,* *71*(2), 255–270. https://doi.org/10.1111/jan.12509

McLaren, B. M., Reilly, R., Zvacek, S., & Uhomoibhi, J. (2019). *Computer supported education: 10th International Conference, CSEDU 2018, Funchal, Madeira, Portugal, March 15–17, 2018, Revised Selected Papers.* Springer.

Mead, C., Buxner, S., Bruce, G., Taylor, W. L., Semken, S., & Anbar, A. D. (2019). Immersive, interactive virtual field trips promote science learning. *Journal of Geoscience Education,* *67*(2), 131–142. https://doi.org/10.1080/10899995.2019.1565285

Mehta, N., Chauhan, S., Gupta, P., & Jaiswal, M. (2021). Pursuing Digital Learning Platform Success: A Meta-Analytic Investigation of user and Cultural Contingencies. *Communications of the Association for Information Systems,* *48*(1), 305–332. https://doi.org/10.17705/1cais.04834

Michalski, R. S. (2012). *Multistrategy learning: A Special Issue of MACHINE LEARNING.* Springer Science & Business Media.

Midgley, C. (2014). *Goals, Goal Structures, and Patterns of Adaptive Learning.* Routledge.

Mieg, H. A. (2019). *Inquiry-Based Learning - Undergraduate research: The German Multidisciplinary Experience.* Springer.

Milan, J. (2015). *Leadership and competence development in higher education.* LAP Lambert Academic Publishing.

Montebello, M. (2017). *AI injected e-Learning: The Future of Online Education.* Springer.

Moro, A. I., Infante-Moro, J., & Gallardo-Pérez, J. (2019). The Importance of ICTs for Students as a Competence for their Future Professional Performance: the Case of the Faculty of Business Studies and Tourism of the University of Huelva. *Journal of New Approaches in Educational Research,* *8*(2), 201. https://doi.org/10.7821/naer.2019.7.434

Moskal, P. D., Dziuban, C. D., & Picciano, A. G. (2023). *Data Analytics and Adaptive learning: Research Perspectives.* Taylor & Francis.

Mulder, M. (2016). *Competence-based vocational and professional education: Bridging the Worlds of Work and Education.* Springer.

Mulder, M. (2017). Competence and the alignment of education and work. In *Technical and vocational education and training* (pp. 229–251). https://doi.org/10.1007/978-3-319-41713-4_11

Natriello, G. J. (2019). *Adaptive learning opportunities: Toward a More Personal Education.*

Nejdl, W., Kay, J., Pu, P., & Herder, E. (2008). *Adaptive hypermedia and adaptive Web-Based systems: 5th International Conference, AH 2008, Hannover, Germany, July 29 - August 1, 2008, Proceedings.* Springer Science & Business Media.

Nicolaidou, I. (2013). E-portfolios supporting primary students' writing performance and peer feedback. *Computers & Education,* *68*, 404–415. https://doi.org/10.1016/j.compedu.2013.06.004

Niemi, H., & Nevgi, A. (2014). Research studies and active learning promoting professional competences in Finnish teacher education. *Teaching and Teacher Education,* *43*, 131–142. https://doi.org/10.1016/j.tate.2014.07.006

Nikou, S. A., & Economides, A. A. (2017). Mobile-based assessment: Investigating the factors that influence behavioral intention to use. *Computers & Education,* *109*, 56–73.

https://doi.org/10.1016/j.compedu.2017.02.00 5

Noroozi, O., & De Wever, B. (2023). *The power of peer learning: Fostering Students' Learning Processes and Outcomes*. Springer Nature.

Oecd. (2023). *Higher education advancing digital maturity in Croatia's higher education system*. OECD Publishing.

Olson, S. J., & Werhan, C. R. (2005). Teacher preparation via online learning: a growing alternative for many. *Action in Teacher Education*. https://doi.org/10.1080/01626620.2005.10463 392

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T., Mulrow, C. D., Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*, n71. https://doi.org/10.1136/bmj.n71

Pappano, L. (2012). The year of the MOOC. *The New York Times*, 2(12).

Parry, J., & Allison, P. (2019). *Experiential learning and outdoor education: Traditions of practice and philosophical perspectives*. Routledge.

Parsons, S. A., Vaughn, M., Scales, R. Q., Gallagher, M. A., Parsons, A. W., Davis, S. G., Allen, M. H. (2017). Teachers' Instructional Adaptations: A Research Synthesis. *Review of Educational Research*, *88*(2), 205–242. https://doi.org/10.3102/0034654317743198

Peña-Ayala, A. (2012). *Intelligent and Adaptive Educational-Learning Systems: Achievements and Trends*. Springer Science & Business Media.

Philipsen, B., Tondeur, J., Roblin, N. P., Vanslambrouck, S., & Zhu, C. (2019). Improving teacher professional development for online and blended learning: a systematic meta-aggregative review. *Educational Technology Research and Development*, *67*(5), 1145–1174. https://doi.org/10.1007/s11423-019-09645-8

Phillips, A., Pane, J. F., Reumann-Moore, R., & Shenbanjo, O. (2020). Implementing an adaptive intelligent tutoring system as an instructional supplement. *Educational Technology Research and Development*, *68*(3), 1409–1437. https://doi.org/10.1007/s11423-020-09745-w

Phon-Amnuaisuk, S., Au, T., & Omar, S. (2016). *Computational intelligence in information systems: Proceedings of the Computational Intelligence in Information Systems Conference (CIIS 2016)*. Springer.

Piaget, J. (1970). Genetic epistemology. *Columbia University Press eBooks*. https://doi.org/10.7312/piag91272

Potkonjak, V., Gardner, M., Callaghan, V., Mattila, P., Guetl, C., Petrović, V. M., & Jovanovic, K. (2016). Virtual laboratories for education in science, technology, and engineering: A review. *Computers & Education*, *95*, 309–327. https://doi.org/10.1016/j.compedu.2016.02.00 2

Pun, J. K. H., Curle, S., & Yuksel, D. (2022). *The use of technology in English medium education*. Springer Nature.

Qi, Q., Wang, J., Ma, Z., Sun, H., Cao, Y., Zhang, L., & Liao, J. (2019). Knowledge-Driven Service Offloading decision for vehicular edge Computing: A deep reinforcement learning approach. *IEEE Transactions on Vehicular Technology*, *68*(5), 4192–4203. https://doi.org/10.1109/tvt.2019.2894437

Raley, K. S. (2020). *Discovering blind spots: analyzing teacher and principal perceptions of principal leadership behaviors*. Lawrence: University of Kansas.

Raphaely, T., & Marinova, D. (2013). Sustainability humanistic education: a new pedagogy for a better world. *International Journal of Education Economics and Development*, *4*(2), 170. https://doi.org/10.1504/ijeed.2013.055039

Rauner, F., & Ahrens, M. (2022). *Measuring professional knowledge: What Knowledge is the Foundation of Professional Skills?* Springer Nature.

Reynolds, R. (2016). Defining, designing for, and measuring "social constructivist digital literacy" development in learners: a proposed framework. *Educational Technology Research and Development*, *64*(4), 735–762. https://doi.org/10.1007/s11423-015-9423-4

Richard, V. E. (2010). *Gaming and Cognition: Theories and Practice from the Learning Sciences: Theories and Practice from the Learning Sciences*. IGI Global.

Riebenbauer, E., & Stock, M. (2015). Förderung unternehmerischen Denkens und Handelns in der universitären Übungsfirma. *Zeitschrift Für Hochschulentwicklung*, *10*(3). https://doi.org/10.3217/zfhe-10-03/08

Rivers, D. J., Nakamura, M., & Vallance, M. (2022). Online Self-Regulated Learning and Achievement in the Era of Change. *Journal of Educational Computing Research*, *60*(1), 104–131. https://doi.org/10.1177/07356331211025108

Ryan, R. M., & Deci, E. L. (2017). Self-Determination Theory: Basic psychological needs in motivation, development, and wellness. *Guilford Press eBooks*. https://doi.org/10.1521/978.14625/28806

Ryoo, J., & Winkelmann, K. (2021). *Innovative Learning Environments in STEM Higher Education: Opportunities, Challenges, and Looking Forward*. Springer Nature.

Saba, F., & Shearer, R. L. (2017). *Transactional distance and adaptive learning: Planning for the Future of Higher Education*. Routledge.

Saltman, K. J., & Means, A. J. (2018). *The Wiley Handbook of Global Educational Reform*. John Wiley & Sons.

Saluti, A. (2022). *The preparator's handbook: A Practical Guide for Preparing and Installing Collection Objects*. Rowman & Littlefield.

Sanger, C. S., & Gleason, N. W. (2020). *Diversity and inclusion in global higher education: Lessons from Across Asia*.

Scales, P. (2012). *EBOOK: Teaching in the Lifelong Learning sector*. McGraw-Hill Education (UK).

Scharenberg, K, Waltner, E., Mischo, C., & Riess, W. (2021). Development of students' sustainability competencies: Do teachers make a difference? *Sustainability*, *13*(22), 12594. https://doi.org/10.3390/su132212594

Schulze, U., Kanwischer, D., & Reudenbach, C. (2013). Essential competences for GIS learning in higher education: a synthesis of international curricular documents in the GIS&T domain. *Journal of Geography in Higher Education*, *37*(2), 257–275. https://doi.org/10.1080/03098265.2012.763162

Schunk, D. H., & Zimmerman, B. J. (2012). *Motivation and Self-Regulated learning: Theory, Research, and Applications*. Routledge.

Schwendimann, B. A., Kappeler, G., Mauroux, L., & Gurtner, J. (2018). What makes an online learning journal powerful for VET? Distinguishing productive usage patterns and effective learning strategies. *Empirical Research in Vocational Education and Training*, *10*(1). https://doi.org/10.1186/s40461-018-0070-y

Scott-Muenter, M. S. (2022). *Investigating self-directed learning and adult learner readiness attributes in a call center environment*. St Charles: Lindenwood University.

Seal, M., & Smith, A. (2021). *Enabling critical pedagogy in higher education*. Critical Publishing.

Sein-Echaluce, M. L., Fidalgo-Blanco, Á., & García-Peñalvo, F. J. (2019). *Innovative trends in flipped teaching and adaptive learning*. IGI Global.

Serrano, D. R., Dea-Ayuela, M. A., González-Burgos, E., Serrano-Gil, A., & Lalatsa, A. (2019). Technology-enhanced learning in higher education: How to enhance student engagement through blended learning. *European Journal of Education*, *54*(2), 273–286. https://doi.org/10.1111/ejed.12330

Sharaff, A., Sinha, G. R., & Bhatia, S. (2021). *New opportunities for sentiment analysis and information processing*. IGI Global.

Shaw-Battista, J., Young-Lin, N., Bearman, S., Dau, K., & Vargas, J. (2015). Interprofessional Obstetric Ultrasound education: successful development of online learning modules; Case-Based seminars; and skills labs for registered and advanced practice nurses, midwives, physicians, and trainees. *Journal of Midwifery & Women's Health*, *60*(6), 727–734. https://doi.org/10.1111/jmwh.12395

Shea, K, Tildesley, M. J., Runge, M. C., Fonnesbeck, C., & Ferrari, M. J. (2014). Adaptive Management and the Value of

Information: Learning Via Intervention in Epidemiology. *PLOS Biology, 12*(10), e1001970. https://doi.org/10.1371/journal.pbio.1001970

Shen, C. W., & Ho, J. T. (2020). Technology-enhanced learning in higher education: A bibliometric analysis with latent semantic approach. *Computers in Human Behavior, 104*, 106177. https://doi.org/10.1016/j.chb.2019.106177

Shen, L. (2017). The role of multicultural information in experiential learning. *Education Libraries.* https://doi.org/10.26443/el.v34i1.300

Shirvani Boroujeni, M. (2018). *Discovering Interaction patterns in online learning environments* (No. THESIS). Lausanne: EPFL.

Shum, S. B., & Luckin, R. (2019). Learning analytics and AI: Politics, pedagogy and practices. *British Journal of Educational Technology, 50*(6), 2785–2793. https://doi.org/10.1111/bjet.12880

Shute, V. J., & Rahimi, S. (2017). Review of computer-based assessment for learning in elementary and secondary education. *Journal of Computer Assisted Learning, 33*(1), 1–19. https://doi.org/10.1111/jcal.12172

Singh, A., Yeh, C. J., Blanchard, S., & Anunciação, L. (2021). *Handbook of Research on Critical Issues in Special Education for School Rehabilitation Practices.* IGI Global.

Smart Sparrow. (n.d.). Smart Sparrow. Retrieved from https://www.smartsparrow.com/

Sottilare, R. A., & Schwarz, J. (2020). *Adaptive instructional systems: Second International Conference, AIS 2020, Held as Part of the 22nd HCI International Conference, HCII 2020, Copenhagen, Denmark, July 19–24, 2020, Proceedings.* Springer Nature.

Spante, M., Hashemi, S. S., Lundin, M., & Algers, A. (2018). Digital competence and digital literacy in higher education research: Systematic review of concept use. *Cogent Education, 5*(1), 1519143. https://doi.org/10.1080/2331186x.2018.1519143

Sun, G., Shen, J., & Lin, J. (2020). *Adaptive Micro Learning - Using Fragmented Time To Learn.* World Scientific.

Sztajn, P., & Wilson, P. H. (2019). *Learning trajectories for teachers: Designing Effective Professional Development for Math Instruction.* Teachers College Press.

Thambusamy, R. X., & Singh, P. (2021). Online Assessment: How Effectively Do They Measure Student Learning at the Tertiary Level? *The European Journal of Social & Behavioural Sciences, 30*(1), 63–76. https://doi.org/10.15405/ejsbs.289

Trautwein, U., & Möller, J. (2016). Self-Concept: Determinants and consequences of academic Self-Concept in school contexts. In *Plenum series on human exceptionality* (pp. 187–214). https://doi.org/10.1007/978-3-319-28606-8_8

TRREE. (n.d.). Retrieved from https://elearning.trree.org/

Tse, S. K., Ki, W. W., & Shum, M. S. K. (2021). *Controversies in medium of instruction reform: The Experience of Hong Kong.* Springer Nature.

Turel, V. (2021). *Design solutions for adaptive hypermedia listening software.* IGI Global.

Uskov, V. L., Howlett, R. J., & Jain, L. C. (2015). *Smart education and smart e-Learning.* Springer.

Uskov, V. L., Howlett, R. J., & Jain, L. C. (2021). *Smart Education and e-Learning 2021.* Springer Nature.

Uskov, V. L., Howlett, R. J., & Jain, L. C. (2022). *Smart education and e-Learning - smart pedagogy.* Springer Nature.

Vabo, G., Fossum, M., & Slettebø, Å. (2021). Nursing students' professional identity development: An integrative review. *Nordic Journal of Nursing Research, 42*(2), 62–75. https://doi.org/10.1177/20571585211029857

Van Schalkwyk, G. J., & D'Amato, R. C. (2015). *From the Confucian Way to Collaborative Knowledge Co-Construction: New Directions for Teaching and Learning, Number 142.* John Wiley & Sons.

Vanslambrouck, S., Zhu, C., Lombaerts, K., Philipsen, B., & Tondeur, J. (2018). Students'

motivation and subjective task value of participating in online and blended learning environments. *Internet and Higher Education, 36,* 33–40. https://doi.org/10.1016/j.iheduc.2017.09.002

Veletsianos, G. (2016). *Emergence and innovation in digital learning: Foundations and Applications.* Athabasca University Press.

Velez-Morey, W. I. (2015). *The effectiveness of adaptive learning tools in passive and active learning environments.*

Vermunt, J. D. (2005). Relations between student learning patterns and personal and contextual factors and academic performance. *Higher Education, 49*(3), 205–234. https://doi.org/10.1007/s10734-004-6664-2

Vindigni, G. (2023a). Decoding Cultural Affinity in Video Games: An examination of narrative expression, visual aesthetics, and interactive design in the digital era. *Advances in Social Sciences Research Journal, 10*(6). https://doi.org/10.14738/assrj.106.14911

Vindigni, G. (2023b). Decoding Cultural Affinity in Video Games: An examination of narrative expression, visual aesthetics, and interactive design in the digital era. *Advances in Social Sciences Research Journal, 10*(6). https://doi.org/10.14738/assrj.106.14911

Vindigni, G. (2023c). Internet-Based Lifelong Learning: Implications for language teaching and semiotic structure principles in media sociology and religion sociology. *Archives of Business Research, 11*(4), 162–170. https://doi.org/10.14738/abr.114.14575

Vindigni, G. (2023d). Eclectic-Procedural Innovation Management Approach with Regard to Community Management Within the German-Language Gaming Industry. *Transactions on Machine Learning and Artificial Intelligence, 11*(2), 93–131. https://doi.org/10.14738/tecs.112.14607

Vindigni, G. (2023e). Exploring Digital Therapeutics: Game-Based and eHealth Interventions in Mental Health Care: Potential, challenges, and Policy implications. *Journal of Biomedical Engineering and Medical Imaging, 10*(3),

177–204. https://doi.org/10.14738/bjhmr.103.14804

Vygotsky, L. S. (1978). *Mind in Society: the development of higher psychological processes.* Retrieved from https://ci.nii.ac.jp/ncid/BA03570814

Walkington, C. (2013). Using adaptive learning technologies to personalize instruction to student interests: The impact of relevant contexts on performance and learning outcomes. *Journal of Educational Psychology, 105*(4), 932–945. https://doi.org/10.1037/a0031882

Wan, J., Li, X., Dai, H., Kusiak, A., Martinez-Garcia, M., & Li, D. (2021). Artificial-Intelligence-Driven Customized Manufacturing Factory: key technologies, applications, and challenges. *Proceedings of the IEEE, 109*(4), 377–398. https://doi.org/10.1109/jproc.2020.3034808

Wanner, T., & Palmer, E. (2018). Formative self- and peer assessment for improved student learning: the crucial factors of design, teacher participation and feedback. *Assessment & Evaluation in Higher Education, 43*(7), 1032–1047. https://doi.org/10.1080/02602938.2018.1427698

Weinert, F. E. (2001). Concept of competence: a conceptual clarification. In: Rychen, D.S. and Salganik, L.H. (Eds.), *Defining and selecting key competencies.* Cambridge: Hogrefe & Huber Publishers, pp.45–65.

Wess, R., Klock, H., Siller, H., & Greefrath, G. (2021). *Measuring professional competence for the teaching of mathematical modelling: A Test Instrument.* Springer Nature.

Westwood, P. (2018). *Inclusive and adaptive teaching: Meeting the Challenge of Diversity in the Classroom.* Routledge.

Whitebook, M. (2003). Early Education Quality: Higher Teacher Qualifications for Better Learning Environments – A Literature Review. *University of California Conference Journal.* Retrieved from https://escholarship.org/content/qt2402638b/qt2402638b.pdf?t=qsizo2

Widiati, U., Hidayati, M., Suryati, N., Suharyadi, Wulyani, A. N., Damayanti, I. L., . . . Prihantoro.

(2023). *Proceedings of the 20th ASIATEFL-68th TEFLIN-5th INELTAL Conference (ASIATEFL 2022)*. Springer Nature.

Wimmers, P. F., & Mentkowski, M. (2016). *Assessing Competence in Professional Performance across Disciplines and Professions*. Springer.

Wirtz, J., Patterson, P. G., Kunz, W. H., Gruber, T., Lu, V. N., Paluch, S., & Martins, A. (2018). Brave new world: service robots in the frontline. *Journal of Service Management*, *29*(5), 907–931. https://doi.org/10.1108/josm-04-2018-0119

Wisdom, S. (2015). *Handbook of Research on Advancing Critical Thinking in Higher Education*. IGI Global.

Wyatt, M., & Dikilitaş, K. (2022). *International Perspectives on Mentoring in English Language Education*. Springer Nature.

Yılmaz, R. (2017). Exploring the role of e-learning readiness on student satisfaction and motivation in flipped classroom. *Computers in Human Behavior*, *70*, 251–260. https://doi.org/10.1016/j.chb.2016.12.085

Zegwaard, K. E., & Rowe, A. (2019). Research-informed curriculum and advancing innovative practices in work-integrated learning. *International Journal of Work-Integrated Learning*, *20*(4), 323–334. Retrieved from https://researchcommons.waikato.ac.nz/handle/10289/13435

Zhong, Z., Zheng, L., Luo, Z., Li, S., & Yang, Y. (2020). Learning to adapt invariance in memory for person re-identification. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 1. https://doi.org/10.1109/tpami.2020.2976933

Zhou, P., Zhou, Y., Wu, D., & Jin, H. (2016). Differentially private online learning for Cloud-Based video recommendation with multimedia big data in social networks. *IEEE Transactions on Multimedia*, *18*(6), 1217–1229. https://doi.org/10.1109/tmm.2016.2537216

Zumbach, J., Schwartz, N., Seufert, T., & Kester, L. (2008). *Beyond Knowledge: the legacy of competence: Meaningful Computer-based Learning Environments*. Springer Science & Business Media.