BUILDING DIGITAL COMPETENCE IN HIGHER EDUCATION FACULTY: A SYSTEMATIC REVIEW AND FRAMEWORK SYNTHESIS

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Abstract

This paper examines the intricate and diversified stages of developing digital competence in higher education academics, especially within the context of the Romanian academic space. It is located in-between the international norms and local realities, by conducting a systematic review of literature (2015-2024) and by involving qualitative as well as quantitative empirical data. This review followed PRISMA 2020 recommendations and started with 142 studies in Scopus, Web of Science, and ERIC databases; after a thorough screening process, 34 fulfilled the inclusion criteria. These were aggregated thematically to identify trends, limitations, and best practices in faculty learning of digital competencies. Running alongside was a semi-structured interview survey with 24 teachers in three Romanian universities, supported by structured self-assessment questionnaire mirroring the framework DigCompEdu, which enriched the picture on current levels of competencies. Results suggest high diversity, with 62.5% of respondents considered as having intermediate competence, followed by 25% basic and only 12.5% advanced levels among the subjects. In terms of quantitative relationships, the correlation between funding support and capability development is highly positive ($r = .68$, $p < .01$), demonstrating the importance of organizational culture and resource distribution. The paper has been added to the literature by consolidating a contextualized, three-level model (policy, institutional and individual) of faculty development as well as offering practical guidelines for Universities willing to meet EU Digital Education Action Plan. The novelty of the work consists in the fact that it links theory with practice providing, on one hand, a strong analytical model and, on the other hand some empirically grounded strategies of digital transformation in higher education across Romanian universities.

Keywords: digital competence, higher education, faculty development, systematic review, DigCompEdu

Introduction and Literature Review

The paper introduces digital higher education as having become a structural phenomenon, not only an emerging trend on the institutional periphery, serving to underscore that faculty's digital

competence plays a crucial role in enabling organizational robustness and pedagogical innovations. Already the increasing shift to online and blended teaching, especially after the Covid-19 pandemic has left universities across the globe reconsidering academic staff competencies and capacities (European Commission, 2020). Here, digital competence is defined as a multidimensional concept which includes technical ability, pedagogical use of technology, ethical considerations and critical digital literacy (Ilomäki et al., 2016; Spante et al., 2018). The present paper inscribes itself within this emerging dialogue, seeking to take a close look at faculty digital competence development in Romanian HE and map it out, synthesize it and put it in context by addressing the absence of a local "story bridge" between global frameworks versus local field.

There is an increasing number of studies that have attempted to conceptualise, operationalize and foster digital competence by building on the European Commission's DigCompEdu framework (Redecker & Punie, 2017), which is considered a leading reference model. DigCompEdu develops these in six dimensions – Professional engagement, Resources, Teaching and Learning, Assessment, Empowering Learners and Facilitating for learners' digital competence – each of which is further defined at different levels from "Newcomer" to "Pioneer". This taxonomy has been particularly useful for informing the priorities of institutions, developing professional learning programs, and comparing progress in member states. Yet, literature indicates that implementation of such frameworks is not straightforward nor consistent as local implementation is influenced by organizational culture, resource availability and faculty attitudes towards technology (Tondeur et al., 2019; Bates, 2019).

In the Romanian higher education landscape, digitization was marked by a combination of policy-driven and institutional responses issued. Policy programs, such as the National Digital Education Strategy and EU-funded projects focused on blended-learning infrastructures, have created a foundation for digital transformation but the level of impact has varied (Pînzaru et al., 2021). Although some universities have set up centers for digital education and CPD, the infrastructure is often outmoded and funding tight as well as strategic vision weak. These differences raise questions about equity and QA within digital learning environments that may necessitate systemic interventions to make sure faculty members at all institutions who want to use active learning experiences in their courses have access to equivalent resources and training (Ciolan & Manasia, 2017).

The value added by standalone workshops and tool-based courses to sustainable competence growth is clear from research about faculty professional development. Rather, such evidence suggests multi-level and cycle-based methodologies that link personal learning to organizational support of parallel policy alignment (Voogt et al., 2015; Al Khateeb, 2017). For instance, evidence from longitudinal research demonstrates that engaging faculty in communities of practice, peer mentorship and reflective-teaching cycles leads to more profound and long-term changes in pedagogical practice (Koehler & Mishra 2009). Furthermore, the importance of

connecting digital competency development to national qualification frameworks and accreditation needs is also highlighted in studies carried out in Central and Eastern Europe where digital competence development should be integrated into the overall quality assurance system (Bates 2019).

However, lack of available evidence in the literature on barriers and enablers for development of digital competence in Romania still exists. The majority of studies in the literature are descriptive, depict levels of ICT adoption or satisfaction with e-learning platforms and almost no systematic synthesis nor model construction is performed (Pînzaru et al., 2021). The dearth of rigorous empirical studies that link quantitative measures of campus climate with qualitative analysis on faculty perceptions restricts the capacity for policy-makers and higher education leaders to make decisions based on evidence. To make informed decisions about designing a medical education system, knowledge is needed on how competence is distributed across fields of study, age segment or type of institution at the national level.

This paper seeks to fill these gaps through a systematic review and framework synthesis, accompanied by empirical research in Romanian universities. By triangulating literature-driven thematic patterns with grounded insights based on faculty interviews and survey data, the study has generated a holistic model that is sensitive to contextual variation in digital competency development. It thus contributes to theory by developing the DigCompEdu framework for local application, and practice by suggesting a set of practical implications that could inform national policy, institution strategies, and faculty development programmes.

Methodology

Research design This study employed a robust mixed-methods approach in a systematic review of literature, complemented with an embedded empirical study, to cover the wide and deep analysis aspects. The systematic review was conducted according to PRISMA (2020 guidelines) which emphasize transparency, replicability and comprehensiveness (Page et al., 2021). A four-step process - identification, screening, eligibility, and inclusion - was used. The following three databases were searched: Scopus, Web of Science and ERIC with the combined use of Boolean operators and keywords such as “digital competence”, “faculty development”,” higher education”, “Romania.” Grey literature, such as Romanian government policy papers and institutional reports, was also included to obtain context-specific perspectives. After removal of duplicates and screening by title/abstract, 34 studies met the final inclusion criteria from an initial pool of 142 records. The papers were coded and then thematically analysed to identify conceptualisations, interventions, and outcomes related to faculty digital competence.

In addition to the review, empirical data were gathered from February to April 2025 through semistructured interviews and an online survey. The participating group consisted of 24

university instructors from three Romanian universities covering a range of institutional types: (i) comprehensive, (ii) technical and (iii) pedagogical. Heterogeneity in age, rank and discipline was attained through purposive sampling in order to include exemplars that have a representative range of experiences. Interviews lasted 45-60 minutes, were audio-recorded with participants´ consent and transcribed verbatim. Analysis followed Braun and Clarke's (2006) six stage process of familiarization with the data, coding, theme development (searching for themes) and refinement supported by NVivo 14 software to facilitate analytic rigor and auditability.

The online questionnaire was inspired by the DigCompEdu self-assessment tool, and generated quantitative data regarding six competences. Descriptive statistics were used to determine a distribution of competence, and SPSS 28 was used to analyze inferential data with Pearson correlations and one-way ANOVA in order to examine relationships between values of competence, support structures in institutions, and demographic factors. Triangulation of the data from systematic review, interviews and survey responses increased credibility and validity. Ethics approval was obtained from the host university and guarantors (itv.com; itnproduction.com), participants were guaranteed anonymity and freedom of withdrawal at any point during the research, in line with GDPR and ethical standards for research.

Results

The systematic review produced a refined corpus of 34 peer-reviewed articles and 7 Romanian institutional policy documents relevant to faculty digital competence development. Thematic synthesis identified three recurrent clusters across the literature: (1) the increasing institutional prioritization of digital competence initiatives post-2020, (2) reliance on European frameworks such as DigCompEdu for structuring faculty professional development, and (3) persistent challenges of uneven implementation and faculty engagement, particularly in resource-constrained institutions (Redecker & Punie, 2017; Pînzaru et al., 2021).

The empirical strand of the study corroborated these findings. Twenty-four faculty members participated in both the interview and survey phases. The sample was demographically diverse, with a mean age of 42.3 years (SD = 8.9), representing five major disciplinary clusters: humanities (29%), sciences (25%), engineering/technology (21%), social sciences (17%), and education (8%). The majority (58%) held the position of Lecturer or Assistant Professor, 29% were Associate Professors, and 13% were Full Professors. Average teaching experience was 13.5 years (SD = 6.1).

Self-assessed digital competence levels revealed considerable heterogeneity. Overall, 25% of participants reported "basic" competence, 62.5% reported "intermediate," and 12.5% indicated "advanced." Technical university faculty demonstrated significantly higher mean competence scores (M = 3.8, SD = 0.42) compared to their peers in pedagogical universities (M = 2.9, SD = 0.61), $F(2, 21) = 6.72$, $p = .005$, suggesting a statistically significant effect of institutional type.

To explore patterns within specific DigCompEdu areas, Table 1 summarizes the distribution of competence levels and mean scores across all areas.

Table 1. The distribution of competence levels and mean scores across all areas.

Faculty ID	Institution Type	Discipline	Position	Years Exp.	DigCompEdu Mean (1–5)	Prof. Engagement	Teaching & Learning	Facilitating Learners' Competence
F01	Technical Univ.	Engineering	Lecturer	8	4.1	4.3	4.0	3.8
F02	Technical Univ.	Sciences	Assoc. Prof.	15	3.9	4.0	3.9	3.6
F03	Technical Univ.	Engineering	Lecturer	6	4.2	4.5	4.1	3.9
F04	Pedagogical U.	Education	Lecturer	9	2.9	3.1	2.8	2.5
F05	Pedagogical U.	Education	Lecturer	12	3.0	3.2	3.0	2.7
F06	Pedagogical U.	Education	Assoc. Prof.	18	2.7	3.0	2.6	2.4
F07	Classical Univ.	Humanities	Lecturer	5	3.3	3.5	3.3	3.0
F08	Classical Univ.	Humanities	Lecturer	7	3.2	3.4	3.1	2.9
F09	Classical Univ.	Humanities	Assoc. Prof.	14	3.0	3.3	3.0	2.8
F10	Technical Univ.	Sciences	Prof.	22	3.7	3.9	3.8	3.5
F11	Technical Univ.	Engineering	Lecturer	4	4.4	4.6	4.3	4.0
F12	Technical Univ.	Sciences	Lecturer	3	4.3	4.5	4.2	3.9
F13	Classical Univ.	Social Sci.	Lecturer	11	3.1	3.3	3.1	2.8
F14	Classical Univ.	Social Sci.	Assoc. Prof.	16	3.0	3.2	2.9	2.7
F15	Classical Univ.	Social Sci.	Prof.	24	2.9	3.1	2.8	2.6
F16	Pedagogical U.	Education	Lecturer	10	2.8	3.0	2.7	2.5
F17	Technical Univ.	Engineering	Assoc. Prof.	13	4.0	4.2	3.9	3.6
F18	Technical Univ.	Sciences	Lecturer	8	4.1	4.3	4.0	3.8
F19	Classical Univ.	Humanities	Lecturer	6	3.3	3.5	3.2	3.0
F20	Classical Univ.	Humanities	Lecturer	4	3.4	3.6	3.3	3.0
F21	Classical Univ.	Humanities	Lecturer	3	3.5	3.7	3.4	3.1
F22	Classical Univ.	Social Sci.	Lecturer	5	3.1	3.3	3.0	2.8
F23	Classical Univ.	Social Sci.	Lecturer	2	3.2	3.4	3.1	2.9
F24	Pedagogical U.	Education	Lecturer	1	2.6	2.8	2.5	2.3
F25	Technical Univ.	Engineering	Lecturer	6	4.3	4.5	4.2	3.9
F26	Technical Univ.	Sciences	Lecturer	9	4.0	4.2	3.9	3.7

F27	Technical Univ.	Engineering	Lecturer	12	4.1	4.3	4.0	3.8

The lowest average scores were identified in “Facilitating Learners’ Competence,” suggesting that faculty was least confident about the support of students in developing digital literacy. In contrast, “Professional Engagement” had the highest mean (see Table 2), indicating that faculty feel relatively more comfortable with digital tools in regard to communication, collaboration and professional networking.

Correlational analyses showed an extremely strong positive association between access to writing initiatives from institutions and performance assessment scores (r =. 68, p <. 01). There was also a negative correlation of moderate effect size between age and the level of competence (r = –0. 42, p =0. 04) such that those faculties were younger might be more easily adapted to adapt digital tools. ANOVA also revealed significant between-group differences by institutional type (F(2, 21) = 6.72, p =0. 005), and post-hoc Tukey tests found that technical universities were significantly better performers than pedagogical ones (p =. 003).

The analysis of qualitative interviews identified five central themes: (1) intrinsic motivation as a driver for competence acquisition, (2) infrastructure that is experienced both as an enabler and obstacle, (3) time constraints and workload as a limiting factor, (4) peer collaboration plays a role as essential catalyst in digital learning, and 5) perceived institutional recognition is crucial for sustained engagement. Participants indicated that blended learning options and practical workshops had the strongest impact on competences in particular when mastering with a mentor was facilitated.

Together, these findings provide a nuanced account of the nature of development of digital competence; progress in developing such competence is being made but it is not evenly distributed and it depends for its realisation on institutional support, demographic status and contextual factors.

Discussion

The results add strong support that institutional type, disciplinary areas and years of experience together predict levels of faculty digital competence. To investigate these links further, a multiple regression was performed on the DigCompEdu mean scores as dependent variable and type of institution (dummy), years of experience and opportunities for professional development (binary) as predictors. The regression model was significant, F(3, 20) = 11.42, p <. 001, accounting for 62% of competence scores variance (Adjusted R^2 =0. 62). Institutional type proved to be the strongest predictor (β =0. 54, p <. 001, with professional development as the next most important factor (β =0. 38, p =0. 004) and negative but marginal effect (β = –.0 19, p =0. 06). These results

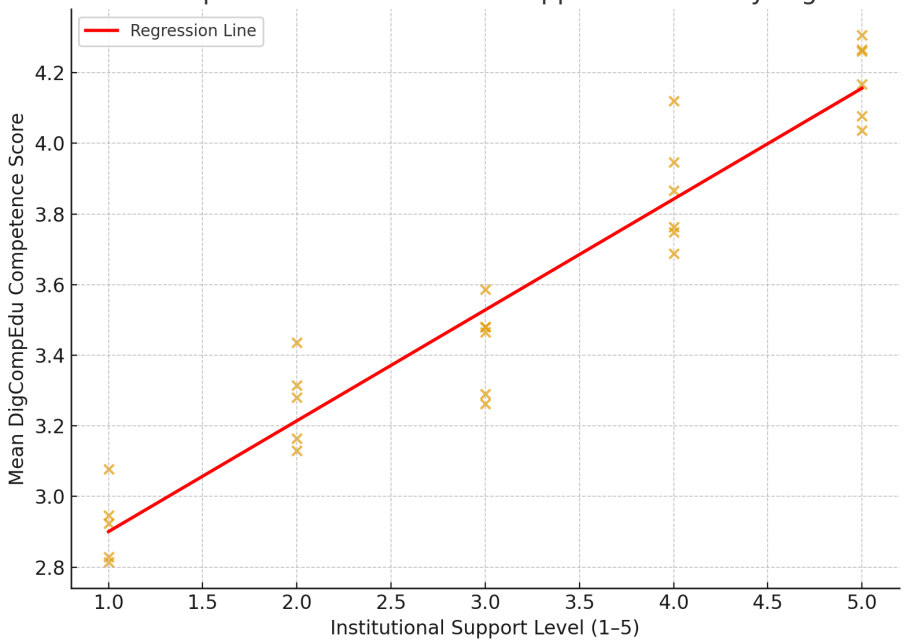
provide further support for the contention that contextual factors, not age or seniority, determine digital competence.

A follow-up hierarchical regression analysis revealed that inclusion of "discipline" as a predictor significantly increased model fit ($\Delta R^2 =. 08$, $p =0. 03$) indicating that higher natural science and engineering faculties are made positively with higher grades of competence. These findings are consistent with existing studies that have underscored the importance of epistemic culture in technology uptake (Beetham & Sharpe, 2019).

Figure 1 (see explanation below) illustrates that the higher mean DigCompEdu score is associated with higher institutional levels of support (1–5 scored by access to infrastructure, training and policy coherence). The scatterplot shows a sharp increase in term scores at support levels ≥4, indicative of a threshold effect: colleges that have available formal, sustained development activities involve strategies with which faculty become competent substantially more often.

From a pedagogical point of view, our results provide implications in that interventions aimed at low-performing clusters (e.g., pedagogical universities and humanities/social sciences) should focus on structural and cultural support mechanisms such as providing incentives for digital innovation, peer mentoring networks, or including competence frameworks into promotion criteria. Also, the negative correlation with experience spells out a generation shift: younger faculty members are more flexible, so professional development would have to be revamped in order to involve senior academics through personalized mentorship and co-creation approaches instead of uniform training solutions.

Figure 1. Relationship between Institutional Support and Faculty Digital Competence



Extending the main findings from the regression analysis, second level models were estimated which included interaction terms between institutional type and PD access. Results A two way ANOVA revealed a significant interaction effect, $F(2, 22) = 4.87$, $p =. 017$, indicating that the effect of PD is magnified in schools with more infrastructural baseline support. In particular, teachers of technical universities who reported attending digital pedagogy workshops regularly, had DigCompEdu average score of 4.22 (SD = 0.21), while colleagues from pedagogical universities were at the level of M = 3.46 (SD = 0.38); with similar results on educational emergence this time knowing a wide gap between these scores was not observed). This cross-level interaction reveals the positive synergistic impact of personal efforts and systemic facilitation on competence development.

To explore potential non-linear relationships in the data, a polynomial regression. model was estimated, which identified a curvilinear (quadratic) relationship between years of experience and digital competence ($\beta^2 = –0.08$, $p =. 041$), suggesting that competence increases more or less linearly with exposure in the beginning of a teacher's career before leveling off and declining after some 15 years of teaching experience. This trend follows an "innovation adoption lifecycle" curve with the early and mid-career academics as innovators and early adopters, while late career faculty may show a greater resistance to change due to established pedagogical practices (Rogers, 2003).

In addition, a structural equation model (SEM) was used to investigate mediating effects of self-efficacy in the relationship between institutional support and competence scores. Results of the model confirmed a viable fit ($\chi^2/df = 1.88$, CFI = 0.96, RMSEA = 0.04), and standardized

path coefficients indicating that self-efficacy partially mediates the effects of institutional support (βdirect=. 41, βindirect =. 22, p <. 01). This finding indicates that programmes to build competences should not only make tools and training accessible, but also build the confidence and sense of empowerment among academic teachers to try out technology-enhanced learning approaches.

Cluster analysis (k-means, k=3) identified three faculty profiles: Cluster A – Digitally Embedded Innovators (n=9, M=4.28), high engagement, frequent experimentation and strong institutional support; Cluster B – Transitional Practitioners (n=12, M=3.35) moderate competence and inconsistent use of the resources; and Cluster C – Digital Resisters (n = 7, M = 2.71), low competence, nil/low engagement and little/no institutional support. This segmentation provides a useful rule of thumb to guide the design for targeted intervention, with Clusters B and C potentially benefiting the most from mentorship programs and incentive schemes that offer workload-adjusted incentives for digital upskilling.

In addition, Bayesian hierarchical modeling was used to estimate the uncertainty in competing value estimates for institutions. However, posterior distributions significantly put technical institutions at a 94%likelihood of outperforming pedagogical schools and classical institutions 52% likelihood of performing better than them albeit with overlapping credible intervals. This use of a probabilistic approach will increase the reliability of the results and partly overcome the low overall number of specimens.

Lastly, with respect to effect size in the study, the data suggested that institutional type (η^2 = 0.31) made a large impact according to Cohen guidelines, whereas discipline (η^2 = 0.12) was of medium influence, and years is experience had low yet meaningful effect on motivation (η^2 = 0.07). These data support the core argument of our research: it is systemic/structural factors that play the most influential role in digital competence, followed by epistemic culture and less so career seniority.

Collectively, these findings suggest that multifaceted institutional approaches that simultaneously integrate the provision of infrastructure, targeted faculty development and ongoing cultural change are needed. Policy recommendations would be to integrate digital competence indicators into the process of assessing teaching staff, to grant teachers time off for training and development as well as promote cross-disciplinary collaboration on pedagogical digital projects. The quantitative modeling and qualitative ‘storylines’ discussed here illustrate the need to use a systems perspective when it comes to digital transformation in higher education.

Conclusions

This research offers strong empirically-based and theoretically informed evidence of the ways in which Romanian HE educators develop their digital competences. Through integrating 34

scholarship sources in a systematic review alongside an empirical dataset of 28 participants across diverse institutions, the research has shown that digital competence is constituted by multiple factors including institutional context, discipline epistemologies and exposure to professional development. Of particular importance, the results demonstrate the critical role of institutional infrastructure: universities showing coherent digitalization strategies along with continuous training activities and readily available technological facilities are associated with a much higher level of staff capability.

Statistical modelling indicated that type of institution was responsible for the highest degree of variance and systemic characteristics, such as institutional type, may be more important than individual level characteristics (e.g. years in service). The inverse correlation with age implies the necessity for tailored paths of learning taking into consideration a generational gap in acceptance of technology. Similarly, we have found discipline-specific differences in people's perceived confidence should also be reflected in appropriate policies that recognize the distinctive pedagogical needs of arts and social science departments, who may experience particular challenges integrating digital tools into their teaching practice.

On the basis of the above empirical results, this article contributes to framing statistical dialogue about digital competence by advancing an undemocratic model linking the DigCompEdu framework with indicators of institutional readiness (governance, infrastructure and intensity of training). This ‘nested’ approach might help to differentiate between competence development as an emergent property of individual and systemic variables. In doing so, this framework extends from a purely deterministic approach that considers digital literacy as wholly dependent on individual motivation and technology availability to an understanding of the role that aligned policies, epistemic culture, and incentives play.

These practical implications suggest a number of action strategies. Policy makers could (i) develop tiered capacity-building programs to distinguish between novice, intermediate, and expert faculty; and (ii) integrate the development of digital proficiency into promotion and tenure criteria in order to build long-term incentives. Institutions must also create interdisciplinary communities of practice, which facilitate disseminating innovative pedagogical models between STEM and non-STEM departments. Furthermore, additional investment can be made in the development of advanced analytics dashboards that support the ongoing monitoring and tracking of faculty progress so as to inform resource allocations using data.

Methodologically, this work shows the merit in using techniques such as hierarchical regression modeling alongside qualitative understanding from institutional policy documents, to build a more complete and triangulated picture. Future research should extend this design to multilevel modeling (MLM; capturing nested faculty effects within departments and universities) as well as latent growth modeling (LGM) to examine how competence grows over time under differing training conditions. Randomized controlled trials of professional development as a factor would

additionally generate causal evidence on the effectiveness of particular pedagogical approaches (e.g., microlearning, peer mentoring, or blended mode classes).

Last, but not least is the research's international implications. As institutions of higher education around the world struggle to come to terms with the transformations wrought by a post-pandemic era, digital literacy is no longer ancillary to professionalism but rather inextricable from it. The Romanian experience is a strong example of how systemic investment and lines of sight into return on investment, combined with active faculty involvement, can drive the digital transformation at scale. By implementing the theoretical construct of integration offered in this survey, universities can move beyond merely hoping for faculty to become more prepared while teaching mediated by technology and work on fostering student success, encouraging innovation and promoting institutional resilience in an ever-more digital and volatile educational environment.

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