

Designing the Framework for Developing Digital Competence among Faculty Members

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Abstract- The primary objective of this research is to identify the key components that contribute to developing digital competence among faculty members and to design a comprehensive framework accordingly. This study employs a descriptive-analytical, factorial approach, combining qualitative and quantitative methodologies. Data for the qualitative phase were collected through interviews, while questionnaires were used for the quantitative phase. The statistical population consisted of 448 faculty members from the University of Tehran, with a sample size of 208 participants. Qualitative data were analyzed using ATLAS.ti software, while descriptive statistics, factor analysis, and validation techniques were applied to analyze the quantitative data. The findings reveal that 21 sub-components contribute to the five main dimensions of digital competence development among professors. These dimensions encompass: 1) Causes and prerequisite factors (such as fundamental changes in communication channels, ongoing redefinition of the current state, capabilities of university and professors, process and organizational aspects, and strategic planning); 2) Fundamental actions (actions undertaken by professors and continuous efforts by the university); 3) Objectives, outcomes, and theoretical and practical knowledge (including planning and decision-making outcomes, quality of education and research outcomes, communication and interaction outcomes, specialized knowledge, personal knowledge development, and general faculty skills); 4) Existing deficiencies and challenges (organizational deficiencies, infrastructural and technological shortcomings, and educational gaps); and 5) Steps and processes for enhancing digital competence (re-engineering existing processes, development of work instructions, infrastructure enhancement, specialized training for professors, and adaptation to rapid environmental changes).

Keywords- Digital Competence, Faculty members, Digital, Competence

Introduction

Higher education is a field greatly influenced by digital technologies, and its ongoing development has created an opportune environment for innovative approaches in the teaching-learning process. However, the research literature suggests that university teaching staff often lack sufficient digital competencies and struggle to adapt their teaching methods to meet the demands of the current digital landscape (Cabero-Almenara, 2013). As digital technologies pervade all aspects of life, new skills and competencies are required to navigate this digital era effectively. Mykhnenko emphasizes that integrating teaching and learning technologies is now considered essential to higher education as significant evidence of innovative teaching practices. Among the various aspects of university professors and digital technologies, their adaptation and proficient use present a complex process, necessitating digital literacy and, ultimately, digital competence (Carrillo, 2018). Conversely, university professors with a strong foundation in ICT knowledge can overcome

challenges and successfully incorporate technology into their teaching practices (Ottenbreit, Liao, Sadik & Ertmer, 2018).

Despite the considerable research on digital competencies in diverse educational contexts, the literature reveals a need for more scientific literature dedicated to university digital competencies education. This gap persists despite the growing recognition of the significance of digital skills in education. UNESCO plays a pivotal role in guiding countries on an international scale in their approach to information and communication technology (ICT) development to expedite progress toward the achievement of the Sustainable Development Goal of ensuring inclusive, equitable, and high-quality education while promoting lifelong learning opportunities for all (UNESCO, 2021).

In today's digital age, teachers must possess various basic or applied digital competencies and exhibit digital leadership in the classroom to empower students and effectively utilize information and communication technology. Various frameworks,

models, and literacies have been developed to guide teacher educators in fostering digital capabilities among learners, enabling them to leverage new and emerging technologies in their future classrooms. This support focuses on integrating digital resources into teaching, enhancing learners' skills in utilizing instructional applications and digital information and understanding the effective combination of pedagogical knowledge, content, and technology to enhance learning outcomes (Falloon, 2020). Simultaneously, teachers must acquire digital skills and competencies to create and exchange digital content, communicate, collaborate, and solve problems (UNESCO Objective 4, 2021). Consequently, teacher training in digital and information literacy becomes indispensable for acquiring and disseminating digital skills that promote the appropriate use of information and communication technology within schools (CLIP, 2021). The research issue arises from the imperative to develop specialized human resources within the education system, empowering and enhancing their digital competence (Farhani, Maryam, Frostkhah, 2013). With the advent of electronic education and its evolution into digital education, faculty members' demand for digital skills has increased (Mihai & Grabka, 2019). Employing information and communication technology is emphasized in educational transformation frameworks to enhance the quality of teaching and learning methods, ultimately improving the educational system's effectiveness. However, a gap exists in the digital competencies of teachers and professors (Arkhi, 2018). The outbreak of the COVID-19 pandemic, leading to the worldwide closure of educational institutions, highlighted the critical significance of digital and distance education—a matter that was not given due attention before the pandemic. The short-term impact of COVID-19 has brought about a significant and unprecedented change in the field of education (Harris & Jones, 2020). Governments and public health systems have implemented extensive measures to curb the spread of the disease. Nevertheless, the resulting stress and socio-psychological effects have posed numerous societal challenges, particularly in education (Abolmaali Alhossieni, 2020). The emergence of COVID-19 has adversely affected health and disrupted economic, educational, and cultural activities worldwide (Mian & Khan, 2020). This sudden shift in the educational paradigm has challenged teachers accustomed to traditional settings as they adapt to emergency online education (Talidong & Toquero, 2021). The enforced change in teaching methods has

underscored that many teachers lack the skills to effectively deliver content through educational software and media. Consequently, educational institutions must prioritize short-term planning to strengthen and enhance teachers' knowledge.

The expansion of digital and electronic communications has given rise to the importance and necessity of research, particularly in the context of distance learning, which has become a prevalent educational approach for working professionals and individuals unable to attend traditional schools and universities (Jamshidi Moghadam & Nowrozi, 2018, p. 3). Consequently, there is a pressing need to reevaluate traditional teaching methods and adopt new approaches to equip learners with essential skills. In a world where digital literacy is recognized as the foundational measure of human literacy, does education rely solely on traditional methods? With the advent of technology in the fourth industrial revolution and innovative educational approaches, teachers' role is transforming (Chai & Kong, 2017; Krammer & Tamm, 2018, p. 3). A digital instructor must proficiently educate students using digital technologies within a virtual learning environment (Ally, 2019, p. 5). Consequently, digital competence, encompassing knowledge, skills, attitudes, capabilities, and digital literacy, has become crucial in education and higher education within the most advanced countries. This strategic emphasis by governments underscores the necessity of further integrating ICT throughout the educational system to prepare students for professional life (Langset, Jacobsen, Haugsbakken, 2018, p. 9).

It is important to note that introducing information technology alone does not guarantee change. Humans are the agents of transformation. Information technology can only alter traditional practices if teachers embrace and implement new habits and practices (Shakibaei Adib, 2014, p. 3). Therefore, a comprehensive understanding of information technology, particularly the internet, as well as appropriate methods for utilizing them to foster e-learning, is a prerequisite for the higher education system's evolution into a knowledge-centric system (Rahmanpour, Liaqat Dar, Afshar, 2014, p. 9).

The primary objective of this research is to identify the influential components necessary for developing digital competence among faculty members and subsequently design a framework based on these findings. The research questions are: What are the influential components for developing digital competence among faculty members, and how can a

framework be designed based on these components? How can the credibility of the resulting framework be validated?

Theoretical Foundation

Digital Competence

Digital Competence refers to knowledge, skills, and attitudes (including abilities, strategies, values, and awareness) necessary when using information and communication technologies and digital media to perform required tasks. These tasks include problem-solving, communication, information management, collaboration, creating and sharing content, and effectively, efficiently, appropriately, critically, creatively, independently, flexibly, ethically, and innovatively utilizing knowledge for work, leisure, participation, learning, socializing, consuming, and empowerment (Ferrari, 2012).

Digital Competence Dimensions

Digital Competence encompasses multiple dimensions, and some of these perspectives have traditionally focused on instrumental aspects that primarily revolve around technology. These instrumental views emphasize developing skills related to information retrieval, evaluation, storage, production, presentation, and exchange using technology. However, Digital Competence goes beyond these technical skills and involves the confident and critical use of Information Society Technology (IST) in various contexts such as work, leisure, and communication (Gentikow, 2015). The core skills within information and communication technologies include utilizing computers for tasks

such as information retrieval, evaluation, storage, production, presentation, and exchange. Additionally, Digital Competence involves actively participating in networks facilitated by the Internet and engaging in collaborative and interactive online environments (European Parliament and the Council, 2006).

Digital Competence is a comprehensive combination of knowledge, skills, and attitudes, encompassing abilities, strategies, values, and awareness essential when utilizing information and communication technologies (ICT) and digital media. It involves performing tasks, solving problems, communicating effectively, managing information, and collaborating efficiently, appropriately, critically, creatively, independently, flexibly, ethically, and innovatively. Digital Competence is applicable in various contexts, such as work, leisure, participation, learning, socializing, consuming, and empowerment. It encompasses content creation and sharing, leading to the generation and expansion of knowledge (Ferrari, 2012: 3).

In addition to technical skills, Digital Competence encompasses cognitive and emotional skills and sociological knowledge crucial for effectively engaging with digital environments (Rokenes & Krumsvik, 2014). Critical thinking skills are essential in Digital Competence, promoting the ability to analyze information and perspectives thoughtfully (Instefjord, 2015).

Gulbahar and Kalelioglu (2015) have compiled competencies for online instructors and educators based on the expertise of other scholars, which are summarized in the table below (Gulbahar & Kalelioglu, 2015).

Table 1: Summary of Compiled Digital Competencies (Gulbahar and Kalelioglu, 2015)

Row	Researcher	Digital Competence
1	Berge (1995)	Educational dimension (subject matter expertise, coaching, and evaluation); Social dimension (interpersonal, communication, and facilitation skills); Managerial dimension (administrative and leadership skills); Technical dimension (technology literacy)
2	Richey et al. (2001)	Professional foundations; Planning and analysis; Design and development; Implementation and management
3	Williams (2003)	Communication and interaction; Training and learning; Management and administration; Utilizing technology
4	Dennis (2004)	Educational; Communication; Field experts; Technological.
5	Klein et al. (2004)	Professional foundations (communications, professional development, law and ethics, and credibility); Planning and preparation; Instructional methods and strategies (motivation, presentation, facilitation, questioning, clarification and correction, skill retention and transfer). Evaluation and assessment; Management (environmental management and appropriate technology use management).
6	Shank (2004)	Executive and administrative management; Design; Facilitation;

Row	Researcher	Digital Competence
		Evaluation; Technical
7	Smith (2005)	Pre-course required competencies; In-course required competencies; Post-course required competencies.
8	Guasch, Alvarez and Espasa (2010)	Design/planning tasks, social tasks, instructional functions, technology domain, and management domain

In Digital Competences, several prominent and existing frameworks have been compiled, including Critical Digital Literacy (Hinrichsen & Coombs, 2013); Teacher Education Information Literacy (TEIL) (Klebansky Hofstetter, 1998); Technological, Pedagogical, and Content Knowledge (Mishra & Koehler, 2006); UNESCO et al. for Teachers (UNESCO, 2011); SAMR¹ Model (Puentedura, 2006); DECK² (Fisher, Denning, Higgins, & Loveless, 2012); PIC - RAT (Ottenbreit-Leftwich, & Kimmons, 2018); ICTE-MM model (Solar, Sabattin & Parada, 2013); International Society for Technology in Education (ISTE) (2017), European Framework for Digital Competence of Educators (Redecker, Carretero, Vuorikari, & Punie, 2017). The summary of these frameworks for introducing and comparing the dimensions under investigation is provided in the following table:

¹ Substitution, Augmentation, Modification, Redefinition

² Distributed Thinking, Engagement, Community, Knowledge Building

Table 2: Summary of Various Digital Competence Frameworks

Row	Framework	Components
1	Critical Digital Literacy (Hinrichsen and Coombs, 2013)	The student's curriculum in teacher education incorporates a blend of technical, operational, conceptual, and semiotic knowledge. This diverse knowledge base is applied across different contexts and types of digital texts. The fields, applications, and objectives of using specific digital text forms have been recognized and identified. <ul style="list-style-type: none"> - Decoding and interpretation of digital texts - Identification of bias and author perspective - Selection and appropriate utilization of tools and digital resources for problem-solving and creating digital content and artifacts - Creating a digital persona - A personal profile that reflects cognitive, ethical, and critical perspectives in using and producing digital materials
2	Teacher Education Information Literacy (TEIL) (Klebansky Hofstetter, 1998)	Students acquire the mechanical (technical) and cognitive/metacognitive skills needed to engage critically with information during knowledge construction by integrating general information literacy skills into subject-based learning tasks. Experts recommend a sequential implementation of these general information literacy skills within specific educational domains, as it enhances students' capacity to learn effectively across diverse disciplines.
3	Technological, Pedagogical, and Content Knowledge (TPACK) (Mishra and Koehler, 2006)	The conceptual model forms the basis of numerous "digital competence" programs within teacher education and the ICT components across disciplines. It is vital in enabling students to grasp the interplay between technology, pedagogical, and content knowledge when designing and implementing technology-enhanced advanced curricula. The model delineates essential theoretical aspects that are pivotal for the effective utilization of technology within the curriculum and elucidates their interconnectedness. However, it does not explicitly outline the specific skills, competencies, or behaviors necessary for their implementation.
4	UNESCO ICT Competency Framework for Teachers (2011)	This framework encompasses teachers' competencies through dedicated programs that cultivate an understanding of the significance of information and communication technology in education. It encompasses various areas, including ICT's role in the curriculum and assessment, technology-enhanced instruction and learning environments, operational ICT skills, ICT for educational organization and management, and the continuous professional development of university educators, encompassing digital citizenship elements. The framework features modules that showcase advancements in these domains across different literacy levels. Additionally, it highlights exemplary curriculum programs that support the acquisition of these competencies.
5	SAMR Model (Puentedura, 2006)	SAMR (Substitution, Augmentation, Modification, Redefinition) is a highly utilized framework within teacher

Row	Framework	Components
		and university faculty education. Similar to other frameworks, SAMR does not outline specific skills or competencies for teachers. Instead, it facilitates the transformation of descriptive measures within the curriculum to align with the increasing integration of technology for learning objectives. This model is a valuable tool for showcasing the diverse applications of digital resources across various curriculum programs.
6	Digital Education Competence Knowledge (Fisher et al., 2012)	A comprehensive framework has been created that revolves around integrating various elements. These elements include information skills (such as accessing and effectively utilizing digital information), personal inclinations and attitudes (such as exploration and taking calculated risks), collaboration, sharing, and knowledge creation through critical information assessment (employing advanced cognitive abilities). This framework is recommended as a "pedagogical tool" in the education of university professors and other educators. It aims to enhance their comprehension of how technology can be purposefully utilized for learning endeavors.
7	PIC-RAT Framework (Ottenbreit-Leftwich & Kimmons, 2018)	While this framework does not explicitly outline or specify particular digital competencies or skills for instructors or learners, it offers a conceptual model that allows for the progression of curriculum design and advanced technology-enhanced instruction. It highlights transitioning from passive substitution modes to more innovative and transformative objectives. The framework underscores the importance of advancing curriculum design and implementing advanced technology-enhanced instruction to meet evolving educational goals.
8	ICTE-MM Model (Solar et al., 2013)	The perspectives outlined in this model extend beyond discussing digital literacy solely regarding instructor capabilities. While the model does not explicitly specify particular skills or knowledge for instructors or learners, it emphasizes the interplay among the five developmental domains. It presents measures for recognizing progress within each domain. It acknowledges the interconnected nature of these domains and offers measures for assessing advancements within each domain rather than solely focusing on the instructor's capabilities.
9	ISTE Standards for Educators (2017)	This framework offers comprehensive measures for university professors and other educators about digital skills, competencies, and behaviors. These measures include establishing a vision, engaging in contemporary research and participating in global networks, nurturing digital citizenship in students, modeling appropriate "digital behaviors" and cultural competencies, and curriculum design and instruction. The ISTE standards can be effectively employed as a holistic framework within professional development programs for university professors and other educators. It serves as a developmental guide for assessing progress within the profession and mapping out advancements in various

Row	Framework	Components
		areas.
10	European Framework for Digital Competence of Educators (Redecker et al., 2017)	This framework encompasses six domains, each representing a distinct competency, resulting in 22 skills. Domain 1 centers around the professional environment, while Domain 2 focuses on sourcing, creating, and sharing digital resources. Domain 3 emphasizes managing and organizing digital tools in teaching and learning, while Domain 4 emphasizes using digital tools and strategies to enhance assessment. Domain 5 highlights the utilization of digital tools to empower learners and Domain 6 centers around facilitating learners' digital literacy. Domains 2 to 5 are considered the core instructional areas, and their respective frameworks comprehensively describe mentoring competencies.

Background Research

Table 3: Current research backgrounds inside and outside the country

Row	Researcher	Results
1	Seyed Taher al-Dini, Hosseini, Ghorchian, Mohammad Davodi (2018)	The development of information and communication technology competencies in faculty members is influenced by several factors, which can be grouped into four dimensions: environmental and technical factors, cultural factors, legal factors, and technological factors. These dimensions have identified and classified nine specific categories and 37 measures. These categories and measures provide a comprehensive framework for understanding the factors contributing to developing ICT competencies among faculty members.
2	Arasteh, Khabareh (2019)	Paying careful attention to policy-making in the following areas is crucial: Educational Policies: Evaluation, monitoring, and quality assurance of digital education, digital content, digital curriculum, and digital teaching-learning processes. Technological Policies: Software and hardware policies and support policies Structural Policies: Digital policies and laws, digital management and leadership Cultural Policies: Digital communication management, internationalization of higher education courses, awareness, and attitudes towards digital courses, access to higher education, and social equity Financial Policy-Making: Financial management, resource mobilization methods, and allocation of financial resources
3	Farhani, Frostkhah (2013).	Faculty members are evaluated based on their professional characteristics, encompassing educational, research, and community service. This evaluation includes the following criteria: 1. Quality of Teaching: The ability to provide high-quality instruction. 2. Training for Teaching in Virtual Courses: Competence in preparing for teaching in virtual environments. 3. Content Selection and Organization: The ability to select

Row	Researcher	Results
		<p>and organize content for virtual learning environments.</p> <p>4. Engagement with Educational or Instructional Technologies: Active involvement with educational or instructional technologies.</p> <p>5. Informed and Proactive Approach to Technology-Enhanced Pedagogy: Being knowledgeable and proactive in integrating technology into teaching and learning processes, particularly in e-learning environments.</p> <p>6. Skill in Working with Learning Management Systems: Proficiency in using learning management systems.</p> <p>7. Adherence to Course Evaluation Standards: Adhering and aligning course evaluation standards with global standards.</p>
4	Mirete, Maquilón , Mirete and Rodríguez (2020)	The researchers have found a positive correlation between the teaching-learning approach and knowledge construction when information technology is utilized. However, they have noted a need for more research exploring the connection between digital teaching competencies and instructional approaches. Despite conducting their studies, they have identified a gap in this area's existing literature. Further research is needed to comprehensively investigate the relationship between digital teaching competencies and instructional approaches.
5	Cabero-Almenara, Romero-Tena, & Palacios-Rodríguez (2020).	The tool demonstrates a strong level of reliability globally across multiple dimensions. The findings suggest the tool is robust enough to differentiate between various topics by considering pertinent technology-related variables.
6	Jiménez, González, Torres, Martínez and Morales (2020)	It is essential for graduates aspiring to become educators to possess digital literacy skills in education. However, there is a need for improvement in the training provided to postgraduate students who are interested in teacher training and seeking to become instructors. These individuals often encounter challenges in creating and sharing digital content with their learners.
7	García, García, and Lugo, (2020)	<p>The study revealed digital competencies encompassing 21 specific skills grouped into five domains. These domains are as follows:</p> <p>1. Information and Data Literacy: Proficiency in reviewing, searching, and filtering data and digital information, evaluating data and digital information, and managing and retrieving digital content effectively.</p> <p>2. Communication and Collaboration: Competence in using digital technologies for interaction, sharing digital information and content, engaging in online citizen participation, collaborating through digital tools, practicing responsible internet usage, and managing digital identity.</p> <p>3. Digital Content Production: Skills in developing digital content, integrating and adapting digital content, understanding copyright and licensing principles, and basic programming knowledge.</p> <p>4. Safety: Competencies in protecting devices and digital content, ensuring personal data and privacy protection, promoting health and well-being in digital environments, and contributing to the preservation of the digital environment.</p>

Row	Researcher	Results
		5. Problem-Solving: Abilities in technical problem-solving, identifying technological needs and appropriate responses, fostering innovation and creative use of digital technologies, and recognizing gaps in digital competence.
8	Falloon, (2020)	This framework introduces two additional sets of integrated competencies: Personal-Ethical and Personal-Professional. The Ethical-Personal competencies encompass the requirements for teacher-trainee students to comprehend, exemplify, and potentially create targeted educational content that aids their students in responsibly, safely, and ethically accessing and utilizing digital resources. The Personal-Professional competencies encompass various skills and abilities, including identifying information needs, employing effective search strategies for digital and non-digital sources, evaluating and organizing information, integrating information for practical application, and engaging in critical thinking and problem-solving.
9	Instefjord, Munthe, (2017).	Among teacher trainers and instructors, there is a weak positive correlation between positive management and development support and digital competency. When teachers, trainers, and instructors receive positive management practices and development support, their digital competencies improve, although the correlation is not strong.
10	Rakenesand, and Krumsvik (2014)	The eight identified approaches are as follows: Participatory Learning, Metacognitive Learning, Blended Learning (online and traditional), Observational Learning and Modeling, Authentic Learning, Student-Centered Learning, Assessment, and Bridging the Theory-Practice Gap. These approaches focus on methods that enhance the digital competence of teacher trainers and instructors through teacher training programs. They aim to equip them with professional ICT skills in the educational system and classrooms.
11	Conde-Jiménez (2018)	The model presented offers a comprehensive and detailed perspective on the dimensions associated with digital competence in educational settings. As a result, it can serve as a valuable tool for assessing the effectiveness of ICT educational policies implemented in educational institutions.
12	Kuzminska, Mazorchuk, Morze, Pavlenko, and Prokhorov (2019).	Digital competence is indeed crucial for success in the digital economy. It is worth noting that both teachers and students generally possess above-average proficiency levels in digital tools and communication. However, the level of competence is independent of the specific method of learning or acquiring these skills. While teachers and students may have similar overall proficiency levels, it is essential to recognize that competence levels can vary across disciplines or subject areas. Some areas may require more specialized digital skills or knowledge than others, depending on the specific context and requirements of the discipline.
13	Portillo, Garay, and Naiara (2020).	Differences in digital competencies among teachers based on gender, age, and type of school highlight the need for policymakers to improve equality, social justice, and flexibility within the education system. Additionally, the low level of technology proficiency at lower educational levels raises

Row	Researcher	Results
		concerns about their vulnerability in virtual teaching. These findings call for policymakers to reflect on necessary measures to promote equality, social justice, and flexibility in education, aligning with sustainable development goals.
14	Mustafa Jwaifell, Osama M. Kraishan, Dima Waswas & Raed Omar Salah (2019)	Digital competencies, attitudes, and how professors utilize digital technology tools in universities are average. According to research, the digital technology tool usage level can be predicted based on university students' competencies and attitudes.
15	Raita (2019)	Professors emphasize the need for specific developmental goals, emotional aspects and self-assessment, improved teaching and education, addressing language barriers, motivation, practical experience, structure, and technical support, and showcasing sample works. Without a systematic framework, guidance, time, and planning, there is a risk of losing motivation and determination for digital competence development.
16	Korucu, Yücel, Gündoğdu, Gençtürk, (2015)	The digital competence of teaching job candidates showed gender-based variations in awareness and technical access, with males and females having a higher level. However, their digital proficiency and motivation levels were relatively low. Furthermore, there were significant differences in overall scores among teaching candidates across different branches. Additionally, candidates for teaching positions displayed notable internet and computer access disparities.
17	Sales, Cuevas-Cerveró, Gómez-Hernández (2020)	The academic faculty members involved in the study hold a critical perspective on students' information and digital competence. They acknowledged that while students are proficient in using technology and mobile phones, they need to improve in evaluating information critically and establishing connections between different pieces of information. Moreover, the faculty members doubted their ability to educate students in digital competence effectively. They attributed the challenges in achieving and promoting such learning to various factors within the university's organizational culture, including a lack of coordination among the teaching staff. The faculty members recognize the fundamental importance of digital competence and support comprehensive research activities to address these issues. The COVID-19 pandemic has been a significant shock to the education system, prompting faculty members to adopt a positive attitude toward developing and strengthening competencies in themselves and their students. The pandemic has highlighted the necessity of enhancing digital skills and has spurred a more significant commitment to fostering these competencies in the academic community.

Research Methods

This study is a descriptive-analytical, factorial, and applied research that integrates qualitative and quantitative approaches. The researchers employed factor analysis as the methodological framework. The qualitative section of the study involved conducting

interviews to gather data, while the quantitative section utilized a questionnaire derived from the insights gained during the qualitative phase.

Statistical Population

The target population for this research was the University of Tehran, faculty members. A two-stage sampling method was utilized. In the qualitative phase, 53 faculty members were initially selected, and contact was made with them through their email addresses obtained from their publications. Eventually, 27 faculty members agreed to participate in face-to-face interviews. The quantitative phase focused on faculty members from specific departments, including Engineering, Humanities, Basic Sciences, Art and Architecture, Literature and Foreign Languages. It resulted in 448 individuals from the University of Tehran being included in the study.

Sampling Method

Simple random sampling was used in the research's quantitative and qualitative stages. In the qualitative phase, initially, 53 faculty members were selected. However, theoretical saturation, which is the point at which new data no longer brings additional insights, was achieved after conducting interviews with 27 individuals. The Morgan Table determined the sample size for the quantitative phase. Out of the 448 faculty members, 208 were randomly selected to participate in the study.

Data Collection Methods

In the qualitative section, data collection involved interviewing faculty members using seven specific questions. The questions were as follows:

1. Describe your theoretical or experiential knowledge in enhancing the digital competence of faculty members.
2. What are the prerequisites and measures of the need for enhancing the digital competence of faculty members?

3. What are the steps, stages, and processes involved in strengthening the digital competence of faculty members?
4. In your opinion, what actions are necessary to enhance the digital competence of faculty members?
5. What are the goals, consequences, and outcomes of enhancing the digital competence of faculty members?
6. Describe the challenges of enhancing faculty members' digital competence.
7. What strategies do you propose for developing the digital competence of faculty members?

The responses obtained from the interviews were then converted into a file format and entered into the ATLAS.ti qualitative analysis software. This software was used for further analysis and interpretation of the qualitative data.

Quantitative Data Collection Method

Based on the data obtained in the qualitative phase, a questionnaire with 200 items was developed, consisting of 7 main dimensions and 21 constructs. After conducting a Delphi method survey, a final set of 87 measures remained. This questionnaire was distributed among 30 respondents to assess its validity and reliability.

Findings

In the first step, seven main scales and 21 sub-scales were defined to address the research question. These constructs served as a foundation for conducting exploratory factor analysis in subsequent stages, allowing for potential adjustments to the number of factors if deemed necessary. The table below displays the original titles of the constructs and sub-scales before undergoing exploratory factor analysis:

Table 4: Description of codes related to research variables categorization

Main Construct	Construct Title	Subscale	Subscale Title
S1	Prerequisites and Factors	C11	Fundamental Changes in Communication Channels
		C12	Continuous Redefinition of the Desired State
		C21	Actions by Faculty Members
S2	Required Actions	C22	Continuous Actions by the University
		C31	Results in Planning and Decision-Making
		C32	Results in Quality of Education and Research
S3	Goals, Consequences, and Outcomes	C33	Results in Communication and Interaction Domain

Main Construct	Construct Title	Subscale	Subscale Title
		C41	Domain-Specific Knowledge
		C42	Personal Knowledge Development
S4	Theoretical and Experiential Knowledge	C43	General Skills
		C51	Organizational Domain Challenges
		C52	Infrastructure and Technology Domain Challenges
S5	Challenges and Existing Issues	C53	Education Domain Challenges
		C61	Capacity-Building Solutions
		C62	Process and Organizational Solutions
S6	Proposed Solutions	C63	Strategic Planning Solutions
		C71	Business Process Reengineering
		C72	Development of Operational Guidelines
S7	Steps, Stages, and Processes for Enhancement	C73	Infrastructure Development
		C74	Specialized Training for Faculty Members
		C75	Adaptation to Rapid Environmental Changes

Through qualitative analysis of the interview data, seven constructs (referred to as S1 to S7) have been identified. The subsequent step involves conducting exploratory factor analysis to determine if the number of constructs is appropriate or if any should be combined. The arrangement of these constructs is utilized to design the confirmatory factor analysis model, considering the number of constructs derived from the exploratory factor analysis output. Each construct comprises multiple measures, denoted by the codes C.

Bartlett's Test of Sphericity was employed to verify the adequacy of the sample size. The Kaiser-Meyer-

Olkin (KMO) measure was utilized, and its value exceeding 0.7 indicates that the sample size is sufficient for conducting factor analysis. Additionally, based on Bartlett's Test of Sphericity outcomes, the null hypothesis of the constructs' matrix being identical was rejected, indicating the presence of correlations between the constructs and enabling uninterrupted factor analysis.

The total variance explained was computed to assess the necessity of merging constructs, and the corresponding results are presented in the following table.

Table 5: Total explained variance

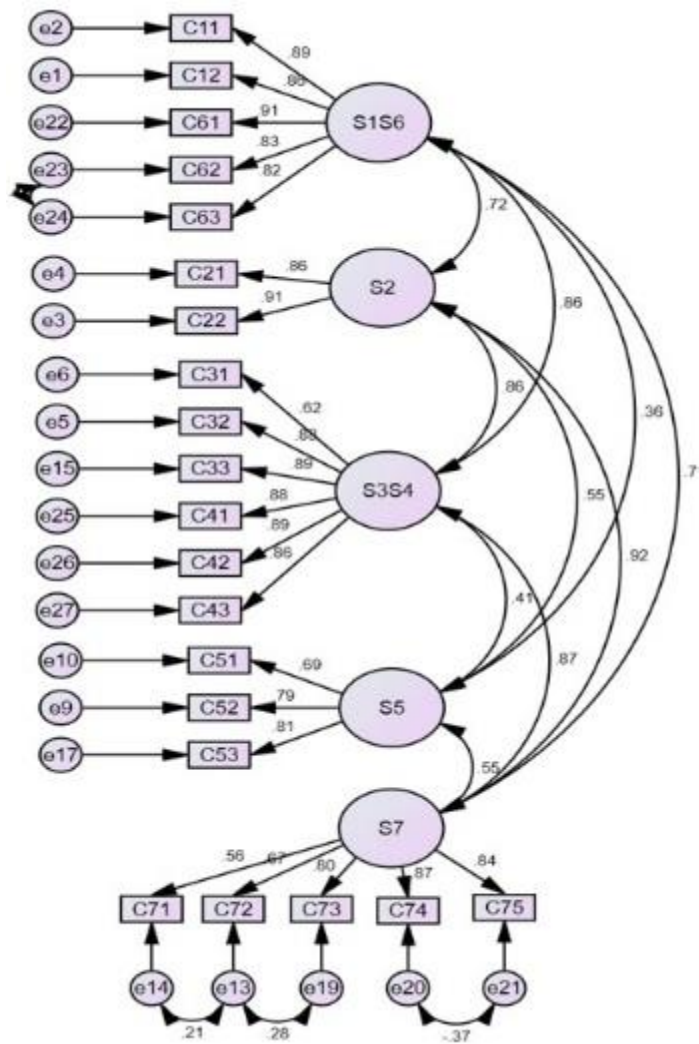
Factor	Extraction Sum of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	Percentage variance	Cumulative sums	Total	Percentage variance	Cumulative sums
1	32.870	37.781	37.781	14.574	16/752	16.752
2	4.145	4.765	42.546	11.361	059/13	29.811
3	3.197	3.674	46.220	6.954	7/993	37.804
4	1.670	1.919	48.139	5.838	6/710	44.514
5	1.473	1.693	49.832	4.543	5/222	49.736
6	1.542	1.773	51.605	1.549	1/780	51.516
7	1.083	1.245	52.850	1.160	1/334	52.850

Based on the provided table, the seven extracted factors account for 52.85% of the total variance of the items. However, considering the qualitative analysis results, two factors were identified with a limited number of items and weak factor loadings. Consequently, it is deemed necessary to merge

certain factors. As a result, the outcome will consist of 5 constructs.

The confirmatory factor analysis model was implemented in the AMOS software to reflect the merged constructs.

Diagram 1- The implemented confirmatory factor analysis model in AMOS software (5 constructs), including factor loadings



Based on the rotated factor matrix resulting from the factor analysis, it was determined that constructs S1 (items 65 to 71) and S6 (items 72 to 87) should be merged. Similarly, constructs S3 (items 41 to 53) and S4 (items 54 to 64) were identified for merging.

An internal consistency assessment was performed to evaluate the reliability of the constructs in the original questionnaire (prior to merging).

Table 6: Reliability of the main constructs of the questionnaire (prior to merging)

Structural code	Structure description	Indicator	Subjects	Cronbach's alpha
S1	Prerequisites and Factors	2	208	0.868
S2	Required Actions	2	208	0.878
S3	Goals, Consequences, and Outcomes	3	208	0.819
S4	Theoretical and Experiential Knowledge	3	208	0.913
S5	Challenges and Existing Issues	3	208	0.806
S6	Proposed Solutions	3	208	0.91
S7	Steps, Stages, and Processes for Enhancement	5	208	0.867

the entire questionnaire (87 items)	21	208	0.958
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Based on the reliability assessment conducted using Cronbach's alpha method, as presented in the provided table, all constructs within the research questionnaire, including the overall questionnaire, exhibit Cronbach's alpha values exceeding 0.7, indicating satisfactory reliability. The overall questionnaire demonstrates a high-reliability coefficient of 0.95. Following merging the S1 and S6 constructs, the newly merged construct exhibits a reliability coefficient 0.938. Similarly, merging the S3 and S4 constructs results in a newly merged construct with a reliability coefficient 0.927.

Table 7: factor loadings related to measures

Relationship between measures and constructs	Factor loading
C12 → S1S6	0.889
C61 → S1S6	0.858
C62 → S1S6	0.907
C63 → S1S6	0.827
C21 → S2	0.818
C22 → S2	0.861
C31 → S3S4	0.91
C32 → S3S4	0.625
C33 → S3S4	0.883
C41 → S3S4	0.886
C42 → S3S4	0.88
C43 → S3S4	0.892
C51 → S5	0.861
C52 → S5	0.694
C53 → S5	0.788
C71 → S7	0.815
C72 → S7	0.562
C73 → S7	0.672
C74 → S7	0.802
C75 → S7	0.872
	0.839

Moreover, based on the factor loadings of the indicators, it is evident that all of the factor loadings, which represent the correlations between the indicators and their respective constructs, exceed the threshold of 0.5. These findings confirm a substantial positive relationship between the indicators and their corresponding constructs.

Table 8: Summary of values for model fit in confirmatory factor analysis

Index	T-test	Status
Cmin / df	2.026	Approved
RMSEA	0.07	Approved

CFI	0.952	Approved
TLI	0.943	Approved
NFI	0.911	Approved

Suppose the Cmin/df (chi-square divided by degrees of freedom) is less than 3 (between 3 and 5 is moderately acceptable). In that case, the RMSEA is less than 0.08 (between 0.08 and 1 is also moderately acceptable), and at least three of the fit indices among the total fit indices are more significant than 0.90, then the desired fit indices for the model are achieved. Consequently, the confirmatory factor analysis (CFA) model demonstrates a satisfactory fit and can be considered validated.

After assessing the adequacy of the model, the focus shifts to construct validity. Convergent validity is confirmed if the composite reliability exceeds 0.70 and the average extracted variance exceeds 0.50. Additionally, discriminant validity is established if the maximum shared squared variance and the average shared squared variance are smaller than the average extracted variance.

The conditions for establishing structural validity are summarized in the following table:

Table 9: Summary of Structural Validity Criteria

Title	Condition of approval
Composite reliability	CR>0.7
Convergent validity	Factor loadings should be significant. CR>AVE AVE>0.5
Discriminant validity	The Fornell-Larcker criterion

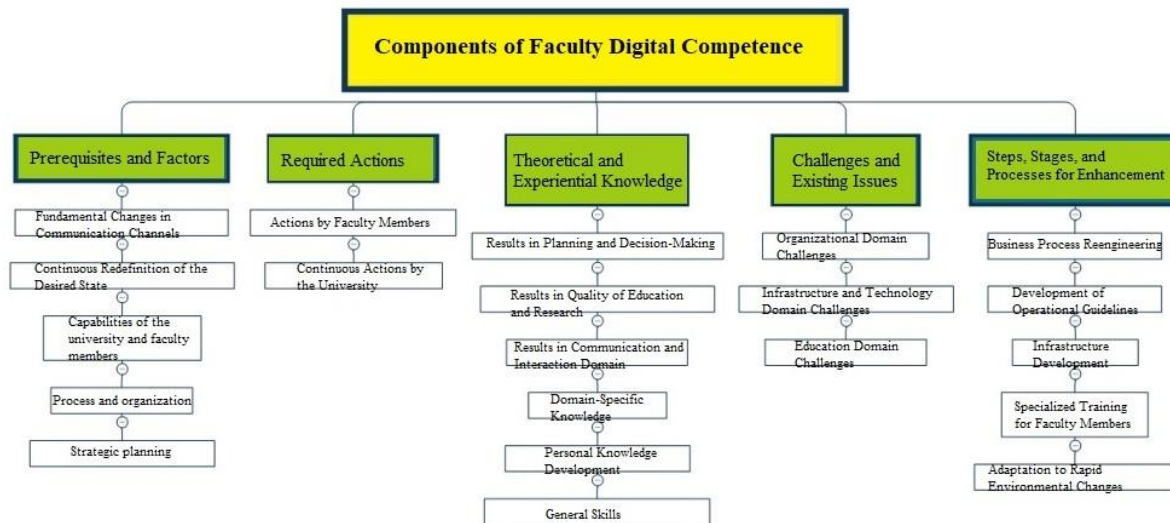
The provided table outlines the specified conditions for establishing the validity of a structure. Consequently, any structure that fulfills these three conditions is considered valid in terms of its structural validity.

Table 10: Fornell-Larcker criterion

S7	S5	S3S4	S2	S1S6	
0.672	0.321	0.818	0.663	0.860	S1S6
0.784	0.463	0.793	0.886		S2
0.796	0.38	0.843			S3S4
0.516	0.767				S5
0.866					S7

Based on the Fornell-Larcker criterion, which places the square root of Average Extracted Variance (AVE)

Diagram2-Frequency of components by final confirmed constructs after confirmatory factor analysis



on the principal diagonal, in all rows and columns, the value on the principal diagonal is greater than the other numbers. Therefore, convergent validity is confirmed.

Table 11: Composite reliability and model validity values of the confirmatory questionnaire

Structure	AVE	CR	Discriminant validity	Convergent validity
S1S6	0.740	0.934	Confirmed	Confirmed
S2	0.785	0.879	Confirmed	Confirmed
S3S4	0.711	0.936	Confirmed	Confirmed
S5	0.589	0.811	Confirmed	Confirmed

Based on the findings in the table above, it is evident that the Critical Ratio (CR) for each factor exceeds the threshold of 0.70. Additionally, the Average Extracted

Variance (AVE) surpasses the value of 0.50. Moreover, the CR values are more significant than the AVE values. Based on these calculations, it can be concluded that convergent validity is confirmed. The formulas used to calculate the AVE and CR values are as follows:

Discussion and Conclusion

This study aimed to investigate the concepts and indicators of digital competence development among faculty members through a comprehensive analysis of conducted interviews. The qualitative data collected from these interviews were analyzed using open and axial coding techniques and factor analysis. Through this analysis, 21 components or sub-themes were identified, encompassing the various aspects of digital competence development among the faculty members at the University of Tehran. These findings are presented in the table provided below.

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