

Utilizing Multi-Criteria Decision-Making for Optimal Selection of a Digital Competency Framework for Higher Education

IHAM TARIQ ISMAIL AL-NUAIMI¹, AHMED N. H. ALNUAIMY¹, HAMID H. JEBUR²

¹University of Baghdad,
Al-Khawarizmi College of Engineering,
IRAQ

²Ministry of Higher Education,
IRAQ

Abstract: - Digital competency frameworks play a pivotal role in shaping modern higher education (HE), particularly in rapidly evolving technological contexts. In Iraq, the integration of robust digital competency frameworks tailored to the specific needs of higher education institutions (HEI) is crucial. However, among numerous available frameworks, selecting the most suitable one poses a significant challenge due to differences in scope, cultural values, practices, available resources, and educational systems. Previous studies or literature in the field have generally overlooked the comparison of competency frameworks to identify the most appropriate one for a given context. This research aims to address this challenge by employing multi-criteria decision-making (MCDM) techniques, including the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), to systematically evaluate and choose the optimal digital competency framework for Iraq's HE among the worldwide frameworks. Evaluating these frameworks involves examining their alignment with institutional goals, adaptability to diverse educational contexts, scalability, and relevance to specific learning objectives. The research findings can inform policymakers, educational leaders, and stakeholders about adopting digital competency frameworks. This could enhance the academic experience, providing learners and educators with essential digital skills needed for the changing global context.

Key-Words: - Higher education, Digital competency, Framework, MCDM, TOPSIS, VIKOR.

Received: March 11, 2026. Revised: June 13, 2026. Accepted: July 15, 2026. Available online: October 22, 2026.

1 Introduction

With the emergence of information and communication technologies (ICT), particularly the Internet, significant efforts have been directed towards developing learning management systems, collaborative editing tools, communication platforms, and other resources. However, challenges have emerged with the integration of ICT into educational contexts [1]. When educators seek to incorporate technology effectively in educational settings, their adoption of technology is significantly influenced by their level of ICT involvement in pre-service and in-service teacher training programs [2], [3]. The integration underscores the need for improved alignment between technology, pedagogical principles, curriculum, content, and teacher trainer competencies within teacher training programs. Teachers should utilize digital technologies appropriately to improve their teaching and educational practices; however, teaching with digital technologies needs digital competencies and

different pedagogical approaches [4]. As a result, digital competence has become highly emphasized in education and is now a fundamental skill for educators within the contemporary education system [5]. According to [6], the digital competence of educators is the ability to make use of digital technologies in their practice. The European Commission (EU) defines digital competency as using ICTs confidently, safely, and purposefully for tasks, leisure, and communication [7], [8]. For educators, digital competence entails not only the ability to use technology but also the capacity to critically reflect on its integration with pedagogy and its implications for student learning within specific contexts [9]. Therefore, preparing educators to use digital technologies effectively and productively in education becomes an ongoing challenge [10]. Educational research has explored teachers' digital competency from diverse theoretical and methodological angles [9]. The results indicate various deficiencies in educators' digital competency across different educational

levels, as well as disparities in attitudes toward technology [11], [12]. The systematic literature review of [13] finds that most university students and teachers have basic digital skills. The digital competency of educators in Iraq presents a considerable challenge, impeding the seamless integration of digital technologies into the education system. A deficiency in essential skills to employ available computer and communication technologies deters e-learning educators' use [14]. A shortage of essential skills, training, and experience among educators hampers their effective utilization and adaptation to these technologies, thereby hindering the delivery of quality education.

Over time, numerous frameworks, models, and literacies have emerged to assist educators in enhancing and measuring their digital competencies to help them use new technologies in their classrooms [10]. Frameworks and theoretical reference models are essential for evaluating and measuring digital competence levels. They offer a systematic method to identify the dimensions and elements of digital competence [5]. Several frameworks have been developed, including the European DigCompEdu (European Framework for Digital Competence of Teachers), UNESCO ICT competency framework for teachers, Technological Pedagogical Content Knowledge (TPACK) framework, the American ISTE (International Society for Technology in Education) standards and performance indicators, the common framework of digital competence for teachers developed by the National Institute of Educational Technology and Teacher Training in Spain. These frameworks serve as valuable tools for identifying the essential features and skills that HE instructors should adopt to integrate technology into their teaching practices effectively and enhance their training and development [5], [15]. The digital competency frameworks support the development and improvement of teachers' digital competencies, consequently enhancing the educational quality and the students' digital competencies [4]. While current frameworks prioritize digital literacy concepts such as technical, pedagogical, and content knowledge, it is contended that these alone are inadequate for preparing teachers for present and future educational landscapes [5]. Furthermore, most frameworks strongly emphasize skills development; however, only TPACK, the UNESCO framework, and, to a lesser extent, the ISTE framework explicitly link skills development to pedagogical and curriculum changes. None of the existing frameworks thoroughly covered personal

attitudes, understanding broader issues, or considering safety and well-being as part of teacher education students' digital competence. Developing digital competencies in HE is crucial for preparing students for a digital society, enhancing the quality of education, and equipping teachers with the skills and knowledge needed to effectively integrate technology into their teaching practices [10]. However, while HEI have predominantly switched to digital learning, there remains a gap in the literature regarding learners' ability to effectively participate in online courses and how their socioeconomic background influences this competency [16]. Moreover, the diverse scopes of current digital competence frameworks, ranging from national to regional and international levels, pose a challenge for researchers and practitioners in selecting the most suitable framework [17]. Research in this field should include various countries due to different teacher training policies across countries. As a result, each country can undertake activities and initiatives tailored to its specific needs [18]. For Iraq, there is a crucial need to adapt one of the current digital competency frameworks or develop a novel one that is relevant and adaptable to the specific requirements of Iraq, taking into account the local context, available resources, cultural aspects, and the professional development requirements of educators. The most suitable framework for Iraq will depend on factors such as alignment with national educational goals, compatibility with existing policies and initiatives, and the capacity for implementation and support. Furthermore, selecting the most suitable framework requires careful consideration of various factors, including the country's educational priorities, technological infrastructure, cultural norms, and available resources.

2 Overview of Current Digital Competency Frameworks

Reviewing and analyzing the most common frameworks can help educators assess which competencies are most relevant to the Iraqi education system, culture, and technological infrastructure. This ensures that the chosen framework aligns with the specific needs and challenges faced by Iraqis. A brief of the framework is introduced in the following:

- UNESCO's ICT Competency Framework for Teachers (ICT CFT), updated in 2018, includes 18 competencies across six areas of a teacher's digital professionalism. These encompass understanding

ICT policy, pedagogy, curriculum, organization, digital skills application, and professional learning [19]. The framework underscores the importance of these competencies in enabling teachers to effectively guide students in developing digital skills [3]. UNESCO's ICT competency framework is a worldwide framework that has been applied to many global contexts and has proved to be effective in some countries, especially in developing nations [3].

- The TPACK (Technological Pedagogical Content Knowledge) model, originating from Shulman's PCK (Pedagogical Content Knowledge), is a foundational framework for effective technology integration in education. It combines three main components—PCK (Pedagogical Content Knowledge), TCK (Technological Content Knowledge), and TPK (Technological Pedagogical Knowledge) to facilitate technology-assisted learning. This model emphasizes the interrelation of technology, content, and pedagogy, encouraging educators to integrate technology seamlessly into teaching practices rather than treating it as an add-on. The TPACK is used worldwide [17], however, it does not specify the types of digital tools that can be used for teaching and learning [20].
- The International Society for Technology in Education (ISTE) developed technology integration standards, which were updated in 2014. These standards outline the essential ICT skills teachers need and their actions for effective technology integration [18]. The ISTE standards include 1) Developing digital-age learning experiences, 2) Facilitating student learning and creativity, 3) Promoting digital citizenship and responsibility, 4) Modeling digital-age work and learning, 5) Engaging in professional growth and leadership. This framework was developed in the United States and adopted by all states and several countries [3].
- The NCCA ICT framework (National Council for Curriculum and Assessment), originating in Ireland, provides a structured approach to integrating ICT into curriculum and assessment for primary and secondary teachers. The framework outlines four interconnected elements: 1) creating, communicating, and collaborating using ICT; 2) developing fundamental knowledge, skills, and concepts; 3) applying ICT in critical and creative thinking; and 4) understanding the social and personal impact of ICT, including responsible and ethical usage. Despite its comprehensive structure, the NCCA ICT framework is not widely adopted and remains relatively unexplored [3].
- The eTQF Framework (European Teachers Competency and Qualifications Framework) aimed to enhance teachers' digital competence and was developed as part of the EU Lifelong Learning Project. The framework includes four competence categories (ICT, Pedagogy, Curriculum and Assessment, Teacher professional development) and four skill levels that include one or more competencies [3].
- The DigComp framework (European Digital Competence Framework) was published in 2013 and revised in 2016 and 2017. It includes five areas: information and data literacy; communication and collaboration; digital content creation; safety; and problem-solving. The framework has been used in several European states as a clear reference for national guidelines, especially in guiding school education [21]. There is a consensus on the DigComp framework at the European level about the components of digital competency. It can be used as a conceptual reference model for other countries or educational institutions.
- The Spanish Ministry of Education developed a generic digital competence model to enhance digital literacy and competence among educators in Spain. It is based on the DigComp Framework of Digital Competence and includes the same five areas. This framework has six competence levels with a structure similar to DigCompEdu [19]. Aligning with DigCompEdu, this framework facilitates Spanish educators' mobility and collaboration across borders.
- The Education and Teaching Foundation, in collaboration with the JISC company, developed the British framework of digital teaching to increase teachers' understanding of using digital technologies to enhance their teaching practices and improve their professional development. The framework includes seven areas, each with three levels: exploration, adaptation, and leadership. The areas are pedagogical approach, pedagogical planning, specific teaching, employability of the students, accessibility and inclusion, self-development, and evaluation [19].
- To understand the teacher's competency, the European Commission's Joint Research Centre introduced the DigCompEdu framework (European framework for digital competence of educators) to match the diverse institutional and contextual demands across various countries, while also being flexible for adjustment and enhancement. It connects the development of digital competence for both teachers and students and can be integrated into institutional capacity-

building efforts. It includes six areas, namely professional engagement, digital resources, teaching and learning (Digital pedagogy), assessment, empowering learners, and facilitating learners' digital competence. The DigCompEdu is comprehensive and most widely used and it can be applied to a wide range of educational settings [22], [23].

- The European Commission's Joint Research Centre also published the European Framework for Digitally Competent Educational Organisations (DigCompOrg), which integrates digital technologies in educational institutions and organizations from various education sectors, including primary, secondary, vocational schools and HEI. The framework includes several elements categorized in seven dimensions: leadership and governance practices, teaching and learning practices, professional development, assessment practices, content and curricula, collaboration and networking, and infrastructure [17].

3 Literature Review

The digital competence frameworks have varying scopes including national, regional, or international, which makes it challenging for researchers and practitioners to decide which framework to adopt in a specific context. Previous research has often ignored comparing competency frameworks to find the best fit for a specific situation. Instead, researchers have mainly relied on existing frameworks or created new ones based on established foundations. In India, [16] utilized the DIGCOMP framework to examine the digital competence of online learners enrolled in a professional degree program and the impact of their socioeconomic situation on their ability to participate effectively in online classes. The results indicate substantial differences in learners' digital competence based on gender, economic status, and academic level, highlighting a digital divide among learners. [18] developed a survey questionnaire based on the DigComp framework to explore pre-service teachers' perspectives on their digital competence in Turkey and to assess potential variations based on factors such as gender, field of study, and self-perceived level of digital proficiency. The results show that the digital competence of the target teachers is moderate and varies meaningfully according to gender, branch, and perceived digital competence level. [6] conducted a systematic literature review to analyze several competency frameworks used in Ibero-

America up to 2022. They analyzed similarities and differences in terms of dimensions to define a concept for building a tool to assess digital competencies. The results indicate that the frameworks are not unified or in consensus. Based on the literature, [20] developed a digital competency framework for mathematics teachers, from the school to the university level, that includes several digital skills categorized in eight dimensions to complete all their activities digitally. The framework provides a comprehensive understanding of how to leverage digital resources for various objectives, such as professional growth, digital pedagogy, and adaptation to modern classrooms. Using the DIGCOMP framework, [24] evaluated digital competency and how it related to the socioeconomic level at three Chilean public universities. [25] developed a digital competency framework for HE in Quebec containing 12 dimensions, each including several elements, which provide a better understanding of the skills. [26] utilized the DigCompEdu to assess teacher competency levels in applying digital technology to physical education at Dublin City University in Ireland. A systematic review of the literature has been conducted by [6] examined the competency frameworks utilized in Ibero-America until 2022. The goal is to establish a foundational concept for developing an evaluation tool for digital competencies and to define similarities and differences in terms of framework dimensions. The findings indicate that there is no agreement or standardization among the frameworks on the digital competency concept, and they have different ideas and categories. Few studies compare the digital competence frameworks to detect differences and similarities in terms of dimensions, structure, scope, etc. [27] conducted a comparative study to analyze six digital competency frameworks to understand competency development. Moreover, they utilized SWOT analysis to investigate the differences between those frameworks. Based on the analysis, all the frameworks have similarities and nuances in understanding digital competence. [7] reviewed the most widely used digital competency frameworks. In the same context, [17] analyzed and compared the digital competence frameworks for education to show differences and similarities among them. The findings indicate that common competencies identified include communication, information and data management, collaboration, sharing, teaching, technical skills, learning, and ethics. Moreover, these frameworks typically include profiles, activities, objectives, examples, descriptors, and

cases illustrating knowledge, attitudes, and skills. The study suggests that digital competence frameworks should be tailored to educational actors (administrators, teachers, students) and levels (early childhood, primary, higher). [3] examined various digital competence frameworks for educators to determine the specific set of skills or frameworks required for the initial education of teachers. The findings reveal a need for empirical validation of digital competency frameworks that can be adapted to context and guide initial teacher preparation. [19] evaluated seven commonly used competence frameworks using expert judgment. According to the results, the Digital Competence European Framework (DigCompEdu) is the most valuable and appropriate reference for massive open online courses, followed by the Spanish Framework. This result is reasonable since the latter is inspired by the former.

4 Problem Statement

There are various deficiencies in educators' digital competency across different educational levels, as well as disparities in attitudes toward technology. Thus, assessing educators' digital proficiency is important to support digital competency in a professional way. Existing digital competency frameworks tailored for developed nations might overlook differences in cultural values, practices, and educational systems in Iraq, which are still in the developmental stage. Literature in this field has generally overlooked comparisons of competency frameworks to identify the most appropriate one for a particular situation. Instead, they predominantly either used existing frameworks or devised new ones based on established criteria. That approach limited the exploration of the small differences between frameworks and how well they fit specific needs. So, there's still rare research about comparing different competency frameworks to pick the best one for certain situations. Consequently, a comprehensive evaluation and comparison of current frameworks to guide tailored selection for particular contexts remain a relatively underexplored area within the existing research body. While this gap remains unfilled in the literature, our research aims to identify a suitable existing framework that aligns with the Iraqi context. This endeavor seeks to support educators in Iraq in assessing their digital competency, with the ultimate goal of enhancing the education system.

5 Methodology

In selecting a framework suitable for HE in developing countries, it's essential to consider factors such as the framework's comprehensiveness, alignment with institutional goals, adaptability to local contexts, and ease of implementation. Additionally, stakeholder involvement and capacity-building efforts are crucial for successful integration and sustainability. Therefore, a framework that allows for customization and addresses the specific needs and challenges of HE in developing countries would be most suitable. Collaboration with international organizations and adaptation of existing frameworks to local contexts may also be beneficial. Numerous frameworks exist, and selecting the most appropriate one poses a substantial challenge due to their varying scope, cultural values, practices, and available resources. Moreover, differences and similarities among the frameworks increase the difficulty of selection. There may be inconsistencies between various frameworks, leading to confusion among educators and stakeholders. Based on the analysis of the frameworks, the most common and widely used frameworks will be selected for an evaluation process based on several criteria. The selected frameworks are UNESCO ICT, DigCompEdu, TPACK, and ISTE. Given that digital competency frameworks vary widely in their scope, structure, target groups, and goals, it is challenging to conduct a detailed analysis of each framework within this study. Therefore, the selection process will focus on identifying the most suitable framework for the Iraqi context based on predefined criteria. This approach ensures that the chosen framework aligns closely with Iraq's specific educational needs, technological infrastructure, and policy objectives. Once the most appropriate framework is selected, relevant authorities and organizations in Iraq can tailor and customize it to better meet local requirements. This customization will involve adjusting the framework's elements to reflect Iraq's unique cultural, social, and educational contexts, thereby enhancing its effectiveness and relevance for Iraqi educators and students. Consequently, the multi-criteria decision-making (MCDM) techniques will be utilized to choose the suitable digital competency framework for Iraq's HE. Multi-criteria decision-making (MCDM) technique is the process of selecting the best alternative from a set of alternatives by taking into account more than one criterion during the selection process. It is one of the most accurate decision-making methods. The

MCDM includes various methods with different characteristics. It used different qualitative and quantitative criteria to select the best solution [28]. The MCDM methods are effective and reliable for policy-making and selecting the most suitable solution [29]. Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is one of the MCDM methods that is used to compare alternatives based on predefined criteria. TOPSIS concept is simple; it determines the best solution based on its closest similarity to the positive ideal solution and its distance from the negative ideal solution [30].

Table 1. Criteria and Sub-Criteria

Criteria	Code	Sub-Criteria	Code
Relevance to Educational Goals	CR1	Alignment with national standards	CR11
		Support for 21st century skills	CR12
Comprehensiveness	CR2	Coverage of competencies	CR21
		Depth of content	CR22
Adaptability	CR3	Flexibility	CR31
		Scalability	CR32
Usability	CR4	Ease of implementation	CR41
		Training and support	CR42
Assessment and Evaluation	CR5	Measurability	CR51
		Feedback mechanisms	CR52
Sustainability	CR6	Long-term viability	CR61
		Resource requirements	CR62
Compatibility	CR7	Integration with existing systems	CR71
		Cultural relevance	CR72
Impact	CR8	Student outcomes	CR81
		Educator development	CR82

Source: created by the author

In this research, the TOPSIS is used to rank the available digital competency frameworks according to their weights and select the best alternative quickly. Applying TOPSIS requires, firstly, establishing criteria and sub-criteria to evaluate various frameworks comprehensively, and secondly, constructing a decision matrix containing the weights for the criteria. The criteria and sub-criteria are identified based on the frameworks' dimensions and the literature review. The literature review underscored common issues such as the necessity for alignment with culturally relevant educational goals, adaptability, and inclusiveness. Based on the distinctive challenges and priorities of Iraqi HE, the criteria were selected to reflect domestic needs. For example, factors such as cultural relevance, support for 21st-century skills, and alignment with national standards were prioritized to make sure that the chosen framework would be efficient and adaptable in the Iraqi context. Consequently, they were subject to a judgment process by academic experts specializing in computer science within Iraqi HE. The experts checked whether the criteria and sub-criteria were

sufficient to evaluate the frameworks. The experts' modifications and comments were considered. The reliability test of the experts' questionnaire shows a value of Cronbach's alpha more than 0.7, which indicates acceptable consistency [31]. The final identified criteria, sub-criteria, and their codes are introduced in Table 1. The coding is used to reduce the table's size and enhance the paper's organization.

6 Results

TOPSIS is a multi-criteria decision analysis method which helps in selecting the best alternative based on multiple criteria. Below are the steps of TOPSIS for selecting the best framework.

1) Construct the Decision Matrix

In this step, the same experts were asked to rate each sub-criterion by providing weights that reflect their relative importance based on their experience and knowledge in the field. The more frequent weight assigned by the experts was considered for each criterion. The decision matrix is shown in Table 2.

Table 2. Decision Matrix

No.	Main Criteria	Sub-Criteria	Framework					
1	CR1	CR11	9	9	7	7	8	
		CR12	9	9	8	8	9	
2	CR2	CR21	8	9	6	8	8	
		CR22	8	8	7	8	8	
3	CR3	CR31	9	9	8	8	8	
		CR32	7	9	6	8	8	
4	CR4	CR41	8	8	6	8	9	
		CR42	9	9	6	8	8	
5	CR5	CR51	8	9	7	8	8	
		CR52	9	9	7	8	8	
6	CR6	CR61	7	8	6	8	8	
		CR62	8	8	7	7	8	
7	CR7	CR71	8	8	7	8	9	
		CR72	8	7	6	7	7	
8	CR8	CR81	8	8	7	9	9	
		CR82	8	9	7	9	7	

Source: created by the author

2) Normalize the Decision Matrix

Each score is divided by the square root of the sum of the squares of all scores in the same criterion.

The normalized value R_{ij} for each criterion is calculated by the following formula:

$$R_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^n X_{ij}^2}} \quad (1)$$

where X_{ij} is the original score for the criterion of each alternative (framework).

For example, to calculate the normalized value for the first criterion of all frameworks in Table 2.

Sum of squares: $9^2 + 9^2 + 7^2 + 7^2 + 8^2 = 81 + 81 + 49 + 49 + 64 = 324$

Square root: $\sqrt{324} = 18$. Therefore, the normalized for UNESCO ICT: $9 / 18 = 0.5$, DigCompEdu: $9 / 18 = 0.5$, TPACK: $7 / 18 \approx 0.39$, ISTE: $7 / 18 \approx 0.39$, DigComp: $8 / 18 \approx 0.45$. All the values are shown in Table 3.

Table 3. Normalized Decision Matrix

Criteria	UNESCO ICT	DigCompEdu	TPACK	ISTE	DigComp
CR11	0.5	0.5	0.39	0.39	0.45
CR12	0.47	0.47	0.42	0.42	0.47
CR21	0.46	0.52	0.35	0.46	0.46
CR22	0.46	0.46	0.41	0.46	0.46
CR31	0.48	0.48	0.43	0.43	0.43
CR32	0.41	0.53	0.35	0.47	0.47
CR41	0.46	0.46	0.35	0.46	0.52
CR42	0.5	0.5	0.34	0.45	0.45
CR51	0.45	0.51	0.39	0.45	0.45
CR52	0.49	0.49	0.39	0.44	0.44
CR61	0.43	0.49	0.37	0.49	0.49
CR62	0.47	0.47	0.42	0.42	0.47
CR71	0.45	0.45	0.39	0.45	0.51
CR72	0.51	0.45	0.39	0.45	0.45
CR81	0.44	0.44	0.39	0.49	0.49
CR82	0.45	0.5	0.39	0.5	0.39

Source: created by the author

3) Construct the Weighted Normalized Decision Matrix

Expert judgments are often subjective and imprecise. Equal weighting was utilized for all criteria to remove experts' bias and confirm that all evaluation criteria have equal contribution to the framework selection procedure. This method highlights a neutral comparison of the competency frameworks while evading domination by any single criterion. Each weight W_j is equal to

$1/15 \approx 0.0667$. The weighted normalized decision matrix V_{ij} (shown in Table 4) is calculated according to the formula below.

$$V_{ij} = W_j \cdot X_{ij} \quad (2)$$

For example, to calculate the weighted normalized value for the framework UNESCO ICT on

"Alignment with National Standards":

$$V = 0.0667 \cdot 0.5 \approx 0.033$$

Table 4. Weighted Normalized Decision Matrix

Criteria	UNESCO ICT	DigComp Edu	TPACK	ISTE	DigComp
CR11	0.033	0.033	0.026	0.026	0.030
CR12	0.031	0.031	0.028	0.028	0.031
CR21	0.031	0.035	0.023	0.031	0.031
CR22	0.031	0.031	0.027	0.031	0.031
CR31	0.032	0.032	0.029	0.029	0.029
CR32	0.027	0.035	0.023	0.031	0.031
CR41	0.031	0.031	0.023	0.031	0.035
CR42	0.033	0.033	0.023	0.030	0.030
CR51	0.030	0.034	0.026	0.030	0.030
CR52	0.033	0.033	0.026	0.029	0.029
CR61	0.029	0.033	0.025	0.033	0.033
CR62	0.031	0.031	0.028	0.028	0.031
CR71	0.030	0.030	0.026	0.030	0.034
CR72	0.034	0.030	0.026	0.030	0.030
CR81	0.029	0.029	0.026	0.033	0.033
CR82	0.030	0.033	0.026	0.033	0.026

Source: created by the author

4) Determine the Positive Ideal and Negative Ideal Solutions

From the weighted normalized decision matrix, we calculate the ideal and negative-ideal solutions. The ideal solution consists of the maximum value for each criterion. The negative-ideal solution consists of the minimum value for each criterion.

Ideal solution (A^*) = [1]

Negative-ideal solution (A^-) = [2]

where J is the set of beneficial criteria

$A^* = [1 \ 0.031, \ 0.032, \ 0.035, 0.035, \ 0.033, \ 0.034, \ 0.033, \ 0.033, \ 0.031, \ 0.034, \ 0.034, \ 0.033, \ 0.033 \ 0.031, \ 0.032, \ 0.035, 0.035, \ 0.033, \ 0.034, \ 0.033, \ 0.033, \ 0.031, \ 0.034, \ 0.034, \ 0.033, 0.033]$

$A^- = [9 \ 0.027, \ 0.029, \ 0.023, \ 0.023, \ 0.023, \ 0.026, \ 0.026, 0.025, \ 0.028, \ 0.026, \ 0.026, \ 0.026, \ 0.026 \ 0.027, \ 0.029, \ 0.023, \ 0.023, \ 0.023, \ 0.026, \ 0.026, \ 0.025, \ 0.028, \ 0.026, \ 0.026, \ 0.026, \ 0.026]$

For example, and for Alignment with National Standards:

Max: 0.033 (UNESCO ICT or DigCompEdu)

Min: 0.026 (TPACK or ISTE)

5) Calculate the Separation Measures

The separation of each alternative from the ideal solution (S^*) and the negative-ideal solution (S^-):

$$S_i^* = \sqrt{\sum_{j=1}^m (v_{ij} - A_j^*)^2} \quad (3)$$

$$S_i^- = \sqrt{\sum_{j=1}^m (v_{ij} - A_j^-)^2} \quad (4)$$

Where V_{ij} is the normalized value for the alternative's criterion.

For example, to calculate the separation measures for the UNESCO ICT:

$S^* = \sqrt{((0.033 - 0.033)^2 + (0.031 - 0.031)^2 + \dots)}$

$S^- = \sqrt{((0.033 - 0.026)^2 + (0.031 - 0.028)^2 + \dots)}$

After the calculations, the separation values from the ideal solution (S^*) and the separation from the negative-ideal solution (S^-) are introduced in Table 5.

Table 5. Separation Measures

Framework	S^*	S^-
UNESCO ICT	0.011	0.022
DigCompEdu	0.007	0.027
TPACK	0.017	0.014
ISTE	0.014	0.018
DigComp	0.013	0.019

Source: created by the author

6) Calculate the Relative Closeness to the Ideal Solution

The relative closeness to the ideal solution is calculated by the formula below. The results of all frameworks are introduced in Table 6.

$$C_i^* = \frac{S_i^-}{S_i^* + S_i^-} \quad (5)$$

For example, and for the UNESCO ICT:

$S^* = 0.011$, $S^- = 0.022$

$C^* = 0.022 / (0.011 + 0.022) \approx 0.667$

Table 6. Relative Closeness

Framework	C^*
UNESCO ICT	0.667
DigCompEdu	0.794
TPACK	0.452
ISTE	0.562
DigCompEdu	0.594

7) Rank the Alternatives

Based on the relative closeness (C^*), the frameworks' ranking is introduced in Table 7.

Table 7. Frameworks Ranking

Framework	Rank
DigCompEdu	1
UNESCO ICT	2
DigComp	3
ISTE	4
TPACK	5

Source: created by the author

The ranking provides a clear preference order based on the given criteria and their weights. The TOPSIS method ranks the alternatives as closest to the ideal solution. The results show that the DigCompEdu framework is closest to the ideal solution followed by the UNESCO ICT framework. As discussed in the previous section, the DigCompEdu framework is comprehensive and widely used [22], [23], and it is applicable to a diverse educational setting. Similarly, the UNESCO ICT framework is a globally recognized standard that has been effectively applied in various international contexts, particularly in developing nations [3].

7 Validation

7.1 VIKOR Method for Validation

VIKOR method is applied for validation by comparing the TOPSIS results. VIKOR is broadly utilized in MCDM analysis (Liu et al., 2026). VIKOR uses the same weighted normalized matrix as TOPSIS.

The VIKOR calculation steps are [32]:

- S_i : Measuring group utility for each framework

$$S_j = \sum_{i=1}^n w_i \cdot \frac{f_i^* - f_{ij}}{f_i^* - f_i^-} \quad (6)$$

- R_i : Measuring the highest regret for each framework

$$R_j = \max_i \left[w_i \cdot \frac{f_i^* - f_{ij}}{f_i^* - f_i^-} \right] \quad (7)$$

- Q_i : VIKOR index

$$Q_j = v \cdot \frac{S_j - S^*}{S^- - S^*} + (1 - v) \cdot \frac{R_j - R^*}{R^- - R^*} \quad (8)$$

where f_i^* and f_i^- are the best and worst values for criterion i , w_j the weight for criterion j . Lower values of S_i , R_i , and Q_i are better

Table 8. VIKOR Results

Framework	S	R	Q	Rank
DigCompEdu	1.905	0.571	0.0	1
UNESCO ICT	3.833	0.667	0.18	2
DigComp	4.967	1.0	0.609	3
ISTE	7.371	1.0	0.694	4
TPACK	16.0	1.0	1.0	5

Source: created by the author

The VIKOR results in Table 8 show that DigCompEdu has the smallest S and regret R and the lowest Q. The VIKOR ranking is identical to TOPSIS ranking.

7.2 Kendall's Coefficient of Concordance (W)

Kendall's coefficient of concordance (W) is a method used to evaluate agreement between objects based on their ranking [33], [34]. In this research, this coefficient is used to evaluate TOPSIS and VIKOR within the same frameworks. The comparison of frameworks ranking is shown in Table 9.

Table 9. Comparisons of Frameworks Ranking

Framework	TOPSIS Rank	VIKOR Rank	Rank Sum
DigCompEdu	1	1	2
UNESCO ICT	2	2	4
DigComp	3	3	6
ISTE	4	4	8
TPACK	5	5	10

Source: created by the author

$$W = \frac{12 S}{m^2 (n^3 - n)} \quad (9)$$

where n is the number of objects (frameworks) = 5, m is the number of methods (TOPSIS and VIKOR) = 2, and S is the sum of squared deviations from their mean. W values range from 0 (no agreement) to 1 (very strong agreement).

$S = \sum (R_i - R)^2$ where R is the mean rank sum

$R = m(n + 1)/2 = 2 \times 6/2 = 6$

$S = (2-6)^2 + (4-6)^2 + (6-6)^2 + (8-6)^2 + (10-6)^2 = 16 + 4 + 0 + 4 + 16 = 40$

Therefore:

$W = 12 \times S / (m^2 (n^3 - n)) = 12 \times 40 / (2^2 \times (125 - 5)) = 480 / 480 = 1.000$

This value indicates very strong agreement between TOPSIS and VIKOR rankings for the five digital competency frameworks.

8 Discussion

It is important not to misinterpret the results by concluding that the other frameworks are not significant for acquiring digital competencies. The judges' preferences and evaluations specifically drive the results. Despite the differences in rankings, it is essential to note that all frameworks have considerable similarities and can be valuable. The differences in preference may be due to specific contextual needs and priorities of Iraq's HE system. Therefore, while the selected framework is deemed most suitable based on this analysis, the other frameworks offer valuable insights and approaches to digital competency. While all frameworks have features that can be adapted to specific contexts or used globally, the level of alignment and applicability may vary. However, several factors affect the framework selection, such as the educational initiative's specific goals, the target audience's needs, and the available resources for implementation and support. In addressing digital competency, Iraqi governments and educational institutions' policies should focus on integrating digital skills into curricula from an early age, providing continuous learning opportunities for professionals, and developing standardized assessments to measure digital competency.

9 Conclusion

In this study, we employed the technique for order preference by similarity to the ideal solution (TOPSIS) to evaluate and select the most suitable digital competency framework for the HE in Iraq. This study uses several criteria to assess the frameworks. The results indicated that the DigCompEdu framework scored the highest overall suitability, followed by the UNESCO ICT framework. These frameworks demonstrate strong alignment with Iraq's educational goals, flexibility, comprehensive coverage of digital competencies, and robust support mechanisms for educators and students. By utilizing TOPSIS, this study offers a transparent and replicable approach for educational decision-makers to select the most suitable digital competency framework. This method ensures that the chosen framework meets current educational standards and addresses the specific cultural and logistical needs of HEI in Iraq. The findings highlight the importance of a structured evaluation process in making informed decisions that enhance the digital capabilities of educators and students alike. Future work will consider using a hybrid MCDM.

Declaration of Generative AI and AI-assisted Technologies in the Writing Process

During the preparation of this work, the author(s) utilized artificial intelligence (AI) technologies solely for the purpose of linguistic refinement and grammatical correction. Following the application of these tools, the author(s) comprehensively reviewed, verified, and edited the resulting text. The author(s) maintain full accountability and responsibility for the accuracy, integrity, and final content of the publication.

References:

- [1] Guillén-Gámez, F.D., et al., *Differential analysis of the years of experience of higher education teachers, their digital competence and use of digital resources: Comparative research methods*. 2022. **27**(4): p. 1193-1213. <https://doi.org/10.1007/s10758-021-09531-4>.
- [2] Adnan, M. and J.J.A. Tondeur, *Preparing the next generation for effective technology integration in education: Teacher educators' perspective*. 2018. **25**(34): p. 2. <https://doi.org/10.13140/RG.2.2.12268.41606>.
- [3] Rakisheva, A. and A. Witt, *Digital competence frameworks in teacher education-A literature review*. Issues and Trends in Learning Technologies, 2023. **11**. <https://doi.org/10.2458/itlt.5205>.
- [4] Tondeur, J., et al., *The HeDiCom framework: Higher Education teachers' digital competencies for the future*. 2023. **71**(1): p. 33-53. <https://doi.org/10.1007/s11423-023-10193-5>.
- [5] Basilotta-Gómez-Pablos, V., et al., *Teachers' digital competencies in higher education: a systematic literature review*. 2022. **19**(1): p. 8. <https://doi.org/10.1186/s41239-021-00312-8>.
- [6] Velandia Rodríguez, C.A., et al., *Digital teacher competence frameworks evolution and their use in Ibero-America up to the year the COVID-19 pandemic began: A systematic review*. 2022. **19**(24): p. 16828. <https://doi.org/10.3390/ijerph192416828>.
- [7] Tomczyk, L. and L. Fedeli, *Digital Literacy among Teachers—Mapping Theoretical Frameworks: TPACK, DigCompEdu, UNESCO, NETS-T, DigiLit Leicester*, in *Proceedings of the 38th International Business Information Management Association (IBIMA)*. 2021, International Business Information Management Association. p. 244-252.
- [8] Baah-Acheamfuor, K., A. Qutieshat, and T.J.E.A.O.-. Yangailo, *Critical Review: Measures of Digital Competency Related to Employability*. 2023. **14**(2): p. 379-391. <https://doi.org/10.13132/2038-5498/14.2.379-391>.
- [9] Skantz-Åberg, E., et al., *Teachers' professional digital competence: An overview of conceptualisations in the literature*. 2022. **9**(1): p. 2063224. <https://doi.org/10.1080/2331186X.2022.2063224>.
- [10] Falloon, G.J.E.t.r. and development, *From digital literacy to digital competence: the teacher digital competency (TDC) framework*. 2020. **68**(5): p. 2449-2472. <https://doi.org/10.1007/s11423-020-09767-4>.
- [11] Pongsakdi, N., et al., *The impact of digital pedagogy training on in-service teachers' attitudes towards digital technologies*. 2021. **26**(5): p. 5041-5054. <https://doi.org/10.1007/s10639-021-10439-w>.
- [12] Starkey, L.J.C.J.o.E., *A review of research exploring teacher preparation for the digital age*. 2020. **50**(1): p. 37-56. <https://doi.org/10.1080/0305764X.2019.1625867>.
- [13] Zhao, Y., et al., *Digital competence in higher education research: A systematic literature review*. 2021. **168**: p. 104212. <https://doi.org/10.1016/j.compedu.2021.104212>.
- [14] Ghazal, S., et al., *Satisfaction of learning management system usage in a blended learning environment among undergraduate students*. 2018. **8**: p. 1147-1156.
- [15] Sillat, L.H., K. Tammets, and M.J.E.s. Laanpere, *Digital competence assessment methods in higher education: A systematic literature review*. 2021. **11**(8): p. 402. <https://doi.org/10.3390/educsci11080402>.
- [16] Vishnu, S., et al., *Digital competence of higher education learners in the context of COVID-19 triggered online learning*. 2022. **6**(1): p. 100320. <https://doi.org/10.1016/j.ssaho.2022.100320>.
- [17] Mattar, J., C.C. Santos, and L.M.J.E.s. Cuque, *Analysis and comparison of international digital competence frameworks for education*. 2022. **12**(12): p. 932. <https://doi.org/10.3390/educsci12120932>.
- [18] Çebi, A. and İ.J.J.o.N.A.i.E.R. Reisoğlu, *Digital competence: A study from the perspective of pre-service teachers in Turkey*. 2020. **9**(2): p. 294-308. <https://doi.org/10.7821/naer.2020.7.583>.

- [19] Cabero-Almenara, J., R. Romero-Tena, and A.J.J.o.n.a.i.e.r. Palacios-Rodríguez, *Evaluation of teacher digital competence frameworks through expert judgement: The use of the expert competence coefficient*. 2020. **9**(2): p. 275-293. <https://doi.org/10.7821/naer.2020.7.578>.
- [20] Joshi, D.R., U. Neupane, and P.R.J.M.T.R.J. Joshi, *Synthesis Review of Digital Frameworks and DEPSWALIC Digital Competency Framework for Teachers from Basic to University Level*. 2021. **13**(2): p. 108-136. <https://doi.org/10.2139/ssrn.4886322>.
- [21] Redecker, *Aligning teacher competence frameworks to 21st century challenges: The case for the European Digital Competence Framework for Educators (Digcompedu)*. 2019. **54**(3): p. 356-369. <https://doi.org/10.1111/ejed.12345>.
- [22] Inamorato dos Santos, A., et al., *The digital competence of academics in higher education: is the glass half empty or half full?* 2023. **20**(1): p. 9. <https://doi.org/10.1186/s41239-022-00376-0>.
- [23] Muammar, S., et al., *Evaluation of digital competence level among educators in UAE Higher Education Institutions using Digital Competence of Educators (DigComEdu) framework*. 2023. **28**(3): p. 2485-2508. <https://doi.org/10.1007/s10639-022-11296-x>.
- [24] Silva-Quiroz, J. and E.M.J.I.J.o.E.T.i.H.E. Morales-Morgado, *Assessing digital competence and its relationship with the socioeconomic level of Chilean university students*. 2022. **19**(1): p. 46. <https://doi.org/10.1186/s41239-022-00346-6>.
- [25] Karsenti, T., et al., *What is the Digital Competency framework?* 2020. **17**(1): p. 11-14. <https://doi.org/10.18162/ritpu-2020-v17n1-04>.
- [26] Wallace, J., et al., *Digital technology and teacher digital competency in physical education: a holistic view of teacher and student perspectives*. 2023. **14**(3): p. 271-287. <https://doi.org/10.1080/25742981.2022.2106881>.
- [27] Yang, L., et al., *A review and comparative study of teacher's digital competence frameworks: Lessons learned*. 2021: p. 51-71.
- [28] Taherdoost, H. and M.J.E. Madanchian, *Multi-criteria decision making (MCDM) methods and concepts*. 2023. **3**(1): p. 77-87. <https://doi.org/10.3390/encyclopedia3010006>.
- [29] ISVAND, H. and M. NAZARI, *Applications of multi-criteria decision-making (MCDM) methods in renewable energy development: A review*. 2020. <https://doi.org/10.22044/RERA.2020.8541.1006>.
- [30] Chakraborty, S.J.D.a.j., *TOPSIS and Modified TOPSIS: A comparative analysis*. 2022. **2**: p. 100021. <https://doi.org/10.1016/j.dajour.2021.100021>.
- [31] Hair, J.F., et al., *PLS-SEM: Indeed a silver bullet*. 2011. **19**(2): p. 139-152. <https://doi.org/10.2753/MTP1069-6679190202>.
- [32] Anvari, A., N. Zulkifli, and O.J.T.i.j.o.a.m.t. Arghish, *Application of a modified VIKOR method for decision-making problems in lean tool selection*. 2014. **71**(5): p. 829-841. <https://doi.org/10.1007/s00170-013-5520-x>.
- [33] Gearhart, A., et al., *Use of Kendall's coefficient of concordance to assess agreement among observers of very high resolution imagery*. 2013. **28**(6): p. 517-526. <https://doi.org/10.1080/10106049.2012.725775>.
- [34] Alam, M.J.I.J.o.S.E., *Multi-Dimensional Financial Performance Ranking and Inter-Rank Agreement Analysis Using Kendall's Coefficient of Concordance (W): Evidence from Selected Cement Companies*. 2026. **41**(10s): p. 1121-1134.

Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

- Dr. Iham and Dr. Ahmed defined the problem statement, developed the theoretical framework, and contributed to the discussion and conclusion sections.
- Dr. Hamid contributed to the results, discussion and conclusion sections.

Sources of Funding for Research Presented in a Scientific Article or Scientific Article Itself

The research is self funded.

Conflicts of Interest

The authors declare that they have no conflicts of interest that could have influenced the design, conduct, analysis, interpretation, or reporting of this research.

Creative Commons Attribution License 4.0 (Attribution 4.0 International, CC BY 4.0)

This article is published under the terms of the Creative Commons Attribution License 4.0

https://creativecommons.org/licenses/by/4.0/deed.en_US