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RESEARCH ARTICLE

Assessing Teachers' ICT Competence and Digital Pedagogical Readiness for Education 4.0: Evidence from a Philippine State College

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ABSTRACT

The transition toward Education 4.0 requires higher education institutions to adopt learner-centered and technology-supported pedagogies. This study examined the ICT integration competencies and pedagogical preparedness of faculty members at Bicol State College of Applied Sciences and Technology in Naga City, Philippines. Using a descriptive-survey design and a competency-based evaluation framework, the research assessed teachers' ICT integration across domains including digital literacy, ICT tool usage, pedagogical application of technology, adaptive teaching strategies, and facilitation of collaborative digital learning. Descriptive statistical analyses were employed to determine the level of ICT competence and readiness for Education 4.0 implementation. Findings indicate that faculty members demonstrate satisfactory ICT integration competencies and strong pedagogical preparedness for technology-enhanced teaching. However, challenges related to time constraints, infrastructure limitations, internet connectivity, and the need for sustained professional development continue to affect effective ICT integration. The study highlights the importance of strengthening institutional support systems to promote sustainable digital pedagogy and provides empirical insights that may inform policy and professional development initiatives in higher education institutions.

1. Introduction

The increasing integration of digital technologies in education, shaped by the demands of the Fourth Industrial Revolution, has led to substantial transformations in teaching practices and institutional priorities worldwide. In this evolving landscape, the concept of Education 4.0 has gained prominence, emphasizing learning environments that are flexible, learner-centered, and oriented toward the development of essential skills through the use of emerging digital technologies. This shift underscores that access to technological tools alone is insufficient; rather, the effectiveness of technology-enhanced education depends on how educators meaningfully integrate these tools into teaching and learning processes. Frameworks advanced by the World Economic Forum (2020) highlight the critical role of teachers in fostering higher-order thinking, collaboration, and

problem-solving skills through digital pedagogy. In a similar vein, the UNESCO (2018) emphasizes that teachers' competencies in information and communication technology (ICT) remain central to the advancement of technology-enhanced education.

Within the Philippine higher education sector, State Universities and Colleges (SUCs) serve a crucial role in expanding access to quality education and contributing to national development. Over the past decade, these institutions have increasingly adopted digital learning platforms and ICT-supported instructional strategies. Despite these developments, persistent challenges continue to affect the effective integration of technology in higher education. Issues such as limited digital infrastructure, uneven levels of ICT competence among faculty members, and insufficient access to sustained professional development opportunities remain evident across institutions. Reports from the Organisation for Economic Co-operation and Development (2021) and the Commission on Higher Education (2020) indicate that, while digital transformation initiatives have been introduced, the extent to which educators are prepared to implement technology-enhanced teaching practices varies considerably.

Despite the expanding body of literature on ICT integration in higher education, empirical studies that examine teachers' readiness within specific institutional contexts remain relatively limited, particularly in regional state institutions outside major urban centers. Much of the existing research focuses on national trends or broad policy perspectives, leaving a gap in understanding how educators within individual institutions experience and navigate the transition toward Education 4.0. Institutional-level investigations are essential, as they provide context-specific insights into the opportunities and constraints that influence technology adoption in actual teaching practice.

This study addresses this gap by examining the ICT readiness of faculty members at Bicol State College of Applied Sciences and Technology in Naga City, Camarines Sur. The institution, which has a long-standing focus on applied sciences and technological education, is currently undergoing a significant transformation following its transition toward becoming the Southeast Asian University of Technology. In recent years—particularly during the disruptions brought about by the COVID-19 pandemic and recurring climate-related events—the institution has expanded the use of online, offline, and blended learning modalities. These developments have further underscored the importance of faculty readiness in effectively integrating ICT into instruction.

1.1. Research Objectives

Against this backdrop, the present study evaluates the level of ICT preparedness among BISCAST faculty in terms of digital literacy, technological competence, pedagogical integration of ICT tools, and the challenges encountered in implementing Education 4.0 practices. By providing empirical evidence from an institutional perspective, the study contributes to a more nuanced understanding of how educators in regional state higher education institutions respond to the demands of technology-driven learning environments. The findings are expected to inform institutional strategies related to professional development, resource allocation, and policy formulation aimed at strengthening the sustainable integration of ICT in higher education. Ultimately, this study seeks to examine educators' ICT competencies, pedagogical preparedness, institutional infrastructure, and the challenges influencing technology integration within the broader context of Education 4.0.

2. Theoretical Framework

This study is grounded in three interrelated theoretical perspectives that inform the integration of technology in teaching and learning: the Technological Pedagogical content knowledge (TPACK) framework (Mishra and Kohler, 2006), teacher digital competence frameworks, and the principles of Education 4.0. Taken together, these perspectives offer a coherent lens for examining how educators adopt, apply, and sustain ICT-supported instructional practices in higher education.

The TPACK framework suggests that the educational value of digital tools extends beyond mere access, depending largely on how these technologies are purposefully aligned with pedagogical goals, learner needs, and instructional strategies (Mishra and Kohler, 2006). Within this view, ICT is positioned not simply as a support mechanism, but as a transformative element capable of reshaping teaching and learning processes. Complementing this perspective, teacher digital competence frameworks particularly the Digital Competence Framework for Education (Redecker, 2017), highlight the central role of educators' knowledge, skills, and dispositions in facilitating meaningful technology integration. Digital competence is thus understood as a multidimensional construct encompassing technical proficiency, pedagogical application, and the capacity to design and manage learning experiences enriched by digital technologies.

The framework is further informed by the principles of Education 4.0 (Hussin, 2018), which advocate for learner-centered, flexible, and technology-enabled educational environments that cultivate collaboration, critical thinking, and other essential 21st-century skills (Miranda etal., 2021) Central to this perspective is the expectation that teaching approaches evolve in response to emerging technologies, enabling more personalized, adaptive, and experiential forms of learning. In this context, teachers assume expanded roles—not only as facilitators of knowledge, but also as designers of dynamic and digitally mediated learning environments.

Taken together, these theoretical perspectives indicate that effective ICT integration is shaped by the interaction between teacher competencies and the broader institutional environment. Guided by this integrated view, the present study examines how teachers' ICT competencies and pedagogical preparedness, in conjunction with institutional conditions, influence the implementation of Education 4.0 in higher education. These theoretical considerations provide the basis for the development of the study's conceptual framework (Koehler etal., 2014; Redecker, 2017).

2.1. CONCEPTUAL FRAMEWORK

The conceptual framework of this study is derived from the integration of the TPACK framework and the principles of Education 4.0 (Mishra and Koehler, 2006); Redecker, 2017). It illustrates how teachers' competencies and institutional conditions interact to influence the integration of ICT in higher education and, ultimately, the implementation of Education 4.0.

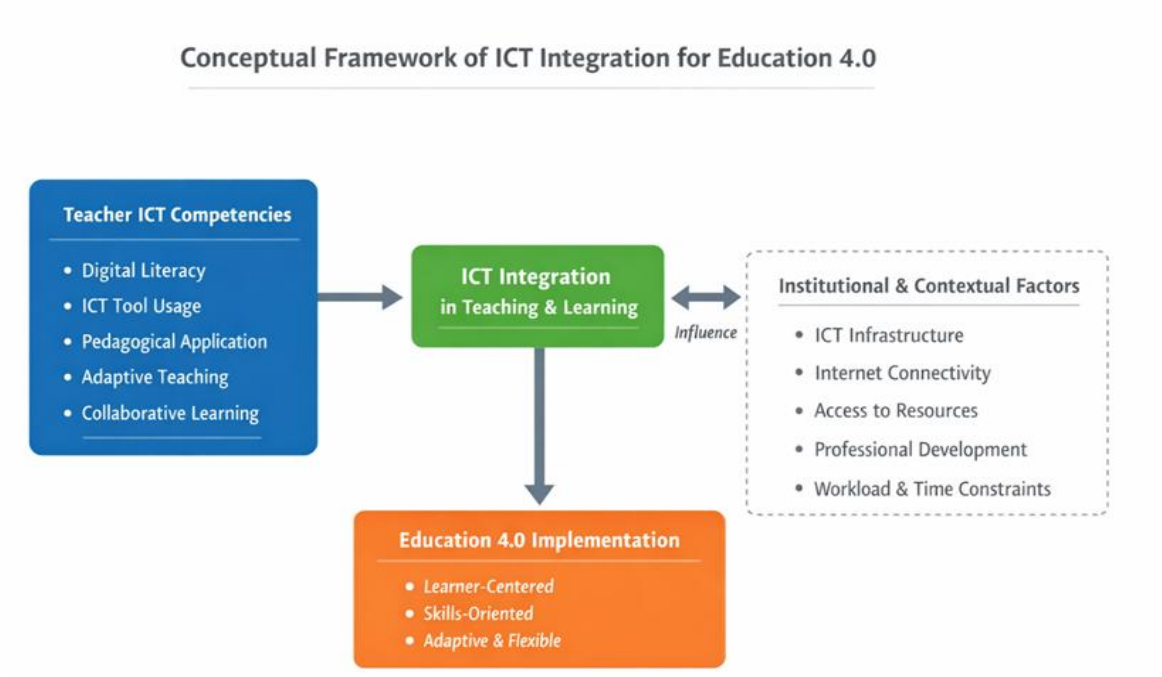
As illustrated in Figure 1, the core of the conceptual framework consists of teachers' ICT competencies, which include digital literacy, proficiency in ICT tools, pedagogical application of technology, adaptive instructional strategies, and the facilitation of collaborative learning through digital platforms. These competencies function as foundational drivers of technology-integrated teaching, shaping the extent and quality of

ICT use in instructional practice (Tondeur etal., 2020; Cabero-Almenara, 2021). When effectively developed, they enable the creation of learning environments that are more learner-centered, flexible, and aligned with the skill demands of Education 4.0.

As further depicted in Figure 1, the application of these competencies in actual teaching contexts, however, is influenced by a range of institutional and contextual factors. These include the availability and reliability of ICT infrastructure, internet connectivity, access to digital resources, opportunities for sustained professional development, and workload-related constraints. Such factors operate as enabling or limiting conditions that determine how effectively teachers can translate their competencies into practice (Howard etal., 2021; Bond etal., 2022).

Figure 1 further shows that ICT integration serves as the central mechanism through which teacher competencies are operationalized, leading to the realization of Education 4.0 (Hussin, 2018; Miranda etal., 2021). This outcome is characterized by the use of digital technologies to support collaborative learning, foster 21st-century skills, and enable more personalized and adaptive instructional approaches (UNESCO, 2023). The framework further assumes a reciprocal relationship between teacher readiness and institutional support: while higher levels of teacher competence enhance ICT integration, strong institutional support systems reinforce and sustain these competencies over time.

Figure 1. Conceptual Framework of ICT Integration for Education 4.0



By examining both teacher-level competencies and institutional conditions, the framework provides a structured basis for understanding the factors that shape effective and sustainable ICT integration in higher education. In doing so, it offers empirical insight into how Education 4.0 can be meaningfully implemented within the context of regional state institutions (Cabero-Almenara etal., 2021).

3. Method

This study employed a descriptive-survey research design complemented by unstructured interviews to examine the ICT integration competencies of undergraduate faculty at the Bicol State College of Applied Sciences and Technology (BISCAST), now transitioning into the Southeast Asian University of Technology, in relation to the implementation of Education 4.0. The use of a mixed-methods approach enabled the systematic identification of patterns, strengths, and areas for improvement in digital teaching practices, particularly across three key competency domains: digital literacy, ICT tool usage, and pedagogical integration.

The participants were selected through purposive sampling and consisted of 91 undergraduate faculty members from BISCAST in Naga City, Camarines Sur, Philippines. The sample represented diverse academic disciplines and professional ranks, including instructors, assistant professors, associate professors, and professors, thereby ensuring variation in teaching experience and professional expertise.

Data were collected using a structured questionnaire adapted from established frameworks, including the UNESCO ICT Competency Framework for Teachers and the Philippine Professional Standards for Teachers (PPST). The instrument was designed to capture the following dimensions: (1) respondents' demographic profiles; (2) levels of ICT competency in terms of digital literacy, ICT tool usage, and pedagogical integration; (3) the status of ICT resources and infrastructure within the institution; (4) teachers' pedagogical preparedness for Education 4.0; (5) perceived challenges and constraints in ICT integration; and (6) proposed recommendations to enhance ICT readiness and digital teaching practices.

Content validity was established through expert evaluation involving three specialists in the field, resulting in a Content Validity Index (CVI) of 1.00, which indicates excellent agreement on the relevance and clarity of the instrument items. The questionnaire was administered in both printed and online formats to facilitate broader participation and accessibility.

Data analysis involved the use of descriptive statistics, including frequency counts, percentages, and weighted means, to summarize and interpret the data. In addition, inferential analysis was conducted using one-way analysis of variance (ANOVA) to determine whether significant differences existed among the identified competency domains. Ethical considerations were strictly observed throughout the study, including the securing of informed consent, voluntary participation of respondents, and the assurance of confidentiality and anonymity of all collected data.

4. Result

4.1. Profile of the Respondents

This section describes the demographic characteristics of the respondents in terms of age, gender, length of service, academic rank, highest educational attainment, and participation in ICT-related training. Frequency counts and percentage distributions were used to summarize these characteristics and to provide an overview of the composition of the study participants. Examining the demographic background of respondents is an important step in educational research because factors such as age, professional

experience, and academic preparation may influence teachers' engagement with professional development activities and their readiness to adopt digital technologies in teaching (Meza-Fregoso et al., 2024). Understanding these characteristics also provides a useful context for interpreting the levels of ICT competence and pedagogical preparedness observed in the study (Ramamurthi et al., 2021; Suryadi et al., 2021).

As shown in Table 1, the respondents represent a relatively diverse age distribution, although a large proportion belongs to the middle-career stage. The largest group of respondents falls within the 40–49 age bracket, followed by those aged 30–39 and those aged 50 and above. Only a small proportion of the participants are in the 20–29 age group. This pattern suggests that the teaching workforce in the institution is composed primarily of experienced educators who have spent a considerable number of years in the profession. Such a demographic structure may be advantageous in terms of pedagogical maturity and instructional expertise; however, it may also imply varying levels of familiarity and comfort with emerging digital technologies, depending on previous exposure to ICT-related training and professional development opportunities.

Table 1: Profile of the Respondents

Categories	Frequency	Percentage
Age (in years)		
20 to 29	11	12.09
30 to 39	24	26.37
40 to 49	32	35.17
50 and above	24	26.37
TOTAL	91	100
Sex		
Male	44	48.35
Female	47	51.65
TOTAL	91	100
Length of Service (in years)		
5 and below	18	19.78
6 to 10	26	28.57
11 and above	47	51.65
TOTAL	91	100
Position		
Instructor	44	48.35
Asst. Professor	24	26.37
Associate Professor	22	24.18
Professor	1	1.10
TOTAL	91	100
Highest Educational Attainment		
Bachelor's degree	13	14.286
Master's degree	56	61.538
Doctorate	22	24.176
TOTAL	91	100
ICT-related training (number attended)		
No training	22	24.18
1 to 2	44	48.35
3 to 5	18	19.78
6 and above	7	7.69
TOTAL	91	100

In terms of gender distribution, the respondents show a nearly balanced representation of male and female educators, with a slight predominance of female participants. This balanced composition indicates that perspectives regarding ICT integration and digital teaching practices are drawn from a relatively equitable representation of both genders, which may contribute to a more comprehensive understanding of faculty readiness for Education 4.0 initiatives.

Regarding professional experience, more than half of the respondents reported having more than ten years of teaching service, while a smaller proportion has between six and ten years of experience, and an even smaller group has five years or less. The predominance of experienced educators suggests that many respondents have developed established teaching practices and classroom management strategies over time. At the same time, this experience may influence how teachers approach technological innovation in teaching, as educators with longer service may require different forms of support or training when integrating new digital tools into their instructional practices.

The distribution of respondents by academic rank further reflects the institutional composition of the teaching workforce. Nearly half of the respondents hold the rank of Instructor, while a considerable number serve as Assistant Professors and Associate Professors. Only one respondent holds the rank of Professor. This pattern indicates that the majority of participants are positioned within the early to mid-level stages of academic career progression, which may have implications for professional development priorities, research engagement, and involvement in institutional initiatives related to technology-enhanced teaching. In terms of educational qualifications, the majority of respondents possess a master's degree, followed by those who have completed doctoral studies, while a smaller proportion holds only a bachelor's degree. This distribution suggests that a substantial number of faculty members have pursued graduate-level education, which may contribute positively to their pedagogical competencies and openness to adopting innovative teaching approaches, including the integration of digital technologies.

Participation in ICT-related training also varies among the respondents. While nearly half have attended one or two training sessions, a notable proportion reported having no prior ICT-related training, and only a small group has participated in more extensive training activities. This variation in training exposure highlights an important institutional consideration: although many educators may possess basic technological competencies, opportunities for sustained and advanced ICT professional development appear to be unevenly distributed. Such differences in training experiences may influence the level of confidence and effectiveness with which teachers integrate digital tools into their instructional practices.

Overall, the demographic profile of the respondents suggests that the institution is supported by a relatively experienced and academically qualified teaching workforce. However, the varying levels of participation in ICT-related training underscore the need for more systematic and continuous professional development programs aimed at strengthening teachers' digital competencies and supporting the broader implementation of technology-enhanced learning environments.

4.2. Level of Teachers' ICT Integration Competency

This section examines the level of teachers' ICT integration competency within the framework of Education 4.0, focusing on three key domains: digital literacy, ICT tool usage, and pedagogical integration. Through weighted mean analysis, the study provides empirical evidence on the extent to which teachers demonstrate technological readiness for technology-enhanced instruction. More importantly, the findings contribute to the growing body of literature on ICT integration in higher education by offering institution-level insights into how educators in a regional state college context engage with digital teaching practices.

As presented in Table 2, the aggregate overall weighted mean of 4.19 indicates that teachers generally demonstrate a satisfactory level of ICT integration competency. This finding suggests that educators possess the fundamental technological knowledge and skills necessary to support instructional practices consistent with the principles of Education 4.0. While previous studies have frequently emphasized gaps in teachers' technological preparedness, the results of the present study indicate that teachers already demonstrate a relatively stable foundation of digital competencies. In this regard, the study contributes empirical evidence showing that the challenge of ICT integration may not necessarily stem from a lack of basic technological skills but rather from other institutional or contextual factors that influence how these competencies are applied in teaching practice. Among the three competency domains, digital literacy obtained the highest overall mean score (WM = 4.32), suggesting that teachers possess strong foundational abilities in operating digital technologies. Respondents reported high levels of confidence in using basic computer applications and in navigating online resources to support teaching activities. These findings reinforce previous research indicating that basic digital literacy remains one of the most established competencies among educators as institutions continue to adopt technology-supported learning environments (Redecker, 2020; Hatlevik et al., 2022). At the same time, the results provide localized evidence that teachers within the institutional context have successfully developed these foundational digital skills, which serve as a critical prerequisite for more advanced forms of ICT integration.

Table 2: ICT Competency Levels (N = 91)

Indicators	**Total W**	**M_W**	**QI**
Digital Literacy			
I am confident in using basic computer applications (e.g. Word, Excel, PowerPoint).	424	4.66	SA
I can navigate the internet effectively to find teaching resources.	413	4.51	SA
I understand basic cybersecurity practices (e.g. password protection, data privacy).	398	4.37	A
I can troubleshoot common technical issues independently.	341	3.75	A
Overall Weighted Mean	394	4.32	A
Tool Usage			
I regularly use digital tools (e.g., LMS, Google Workspace, Zoom) in my teaching.	379	4.17	A
I am familiar with educational apps and platforms relevant to my subject area.	377	4.17	A
I integrate multimedia (videos, simulations, interactive content) into my lessons.	384	4.22	A

I use assessment tools (e.g., online quizzes, polls) to evaluate student learning.	345	3.79	A
Overall Weighted Mean	371	4.08	A
Pedagogical Integration			
I design lessons that incorporate ICT to enhance student engagement.	366	4.02	A
I align digital tools with learning outcomes and competencies.	372	4.09	A
I adapt my teaching strategies based on available ICT tools.	381	4.19	A
I encourage students to use technology for collaborative learning.	400	4.40	A
Overall Weighted Mean	380	4.18	A
Aggregate Overall Weighted Mean		4.19	A

With respect to ICT tool usage, teachers also demonstrated a satisfactory level of competency (WM = 4.08). Respondents indicated that they regularly utilize digital platforms, multimedia materials, and online communication tools as part of their instructional strategies. The frequent use of multimedia elements—such as videos, simulations, and interactive content—reflects the gradual shift toward more dynamic and technology-supported teaching practices. These findings support earlier studies emphasizing that multimedia integration has become an increasingly common feature of modern pedagogical approaches aimed at improving student engagement and facilitating deeper learning (Almulla, 2020; Wang, 2023). However, the slightly lower ratings associated with digital assessment tools suggest that teachers may still be exploring more advanced applications of technology for evaluating student learning outcomes. This observation highlights a potential area for targeted professional development.

Similarly, the pedagogical integration dimension registered a satisfactory level of competency (WM = 4.18). Teachers indicated that they design lessons that incorporate digital technologies to enhance student engagement and encourage collaborative learning. Notably, the highest-rated indicator within this domain relates to teachers' encouragement of students to use digital tools for collaboration. This finding aligns with contemporary educational approaches that emphasize learner-centered environments and collaborative knowledge construction supported by digital platforms (Blau & Shamir-Inbal, 2021; García-Peñalvo, 2022). The results therefore suggest that teachers are not only capable of using technological tools but are also beginning to integrate them in ways that promote interactive and participatory learning experiences.

Taken together, the results demonstrate that teachers exhibit relatively balanced competencies across the three domains of ICT integration. The findings therefore contribute to current discussions on Education 4.0 by suggesting that educators in higher education institutions may already possess the essential technological foundations required for digital teaching. Rather than indicating a deficiency in teacher competence, the results highlight the importance of sustaining institutional support mechanisms that allow educators to further expand their pedagogical use of technology. Continuous professional development programs, improved access to technological resources, and supportive institutional policies remain crucial in enabling teachers to fully realize the potential of ICT integration in higher education.

To determine whether significant differences exist in teachers' competency levels across the three ICT domains—digital literacy, tool usage, and pedagogical integration—a one-way analysis of variance (ANOVA) was conducted. As presented in Table 3, the results indicate that the differences among these domains are not statistically significant ($F = 0.7388$, $p = 0.5077$). This means that teachers' competency levels across the three areas are relatively comparable.

Table 3 further shows that the between-group variation has a sum of squares (SS) of 0.119 with 2 degrees of freedom, resulting in a mean square (MS) of 0.0595, while the within-group variation has a sum of squares of 0.6445 with 8 degrees of freedom and a mean square of 0.0806. The computed F-statistic of 0.7388 and p-value of 0.5077, which is greater than the 0.05 level of significance, indicate that the observed differences in teachers' competency levels across the three ICT domains are not statistically significant. These results suggest that teachers demonstrate relatively balanced competency in digital literacy, tool usage, and pedagogical integration.

Table 3: ANOVA Summary

Source	Df	SS	MS	F-Stat	P-Value
Between Groups	2	0.119	0.0595	0.7388	0.5077
Within Groups	8	0.6445	0.0806		
Total	10	0.7635			

The absence of statistically significant differences provides an important insight into the pattern of ICT competency development among educators. Rather than demonstrating uneven or fragmented skill acquisition, teachers appear to have developed a relatively cohesive set of digital competencies that span foundational skills, technological tool usage, and pedagogical application. This finding contributes to the understanding of ICT readiness in higher education by suggesting that teachers' competencies are evolving in a more integrated manner, where technical skills and instructional practices develop simultaneously. From an institutional standpoint, this outcome suggests that initiatives to enhance ICT integration must not concentrate exclusively on advancing a single competency domain. Capacity-building initiatives might gain from embracing a holistic strategy that fosters both technological skills and instructional creativity. These strategies can also improve teachers' preparedness to adopt technology-infused teaching methods while remaining in line with the overarching objectives of Education 4.0.

4.3. ICT Resources and Infrastructure

Table 4 presents teachers' perceptions regarding the adequacy of ICT resources and infrastructure within the institution. The overall weighted mean of 3.37, interpreted as Neutral, indicates that while certain ICT facilities are available, respondents perceive the institutional technological environment as only moderately supportive of full ICT integration. This result suggests that although some foundational resources exist, there remain important infrastructural and institutional gaps that may influence the effective implementation of Education 4.0 initiatives.

Table 4: ICT Resources and Infrastructure

ICT Resources and Infrastructure	Total W	M_W	QI
The institution provides adequate access to computers/laptop for teaching.	375	4.12	A
Internet connectivity in the campus is reliable and sufficient for instructional use.	265	2.91	N
Classrooms are equipped with ICT facilities (e.g. projectors, Smart boards).	268	2.94	N
Technical support is readily available when ICT issues arise.	335	3.68	A
I have access to professional development programs focus on ICT integration.	290	3.19	N
Overall Weighted Mean	307	3.37	N

A closer examination of the indicators reveals that teachers generally agree that the institution provides adequate access to computers or laptops for instructional use (WM = 4.12). Respondents also expressed agreement that technical support services are available when ICT-related issues arise (WM = 3.68). These findings highlight two institutional strengths—hardware accessibility and technical assistance—which are widely recognized in the literature as critical enabling factors for technology adoption in educational environments. Studies have consistently emphasized that the availability of appropriate devices and responsive technical support systems significantly encourages educators to incorporate digital tools into their teaching practices (Ertmer & Ottenbreit-Leftwich, 2020; UNESCO, 2021).

Despite these positive aspects, the findings also reveal several areas that require institutional improvement. Respondents expressed neutral perceptions regarding the reliability of campus internet connectivity (WM = 2.91), the availability of ICT-equipped classrooms (WM = 2.94), and access to professional development opportunities focused on ICT integration (WM = 3.19). These responses suggest that while teachers may have access to basic hardware, the broader technological ecosystem necessary to support effective digital teaching practices remains only partially developed. Reliable connectivity and well-equipped learning spaces are particularly critical components of modern educational environments, as they enable the consistent and meaningful use of digital platforms, multimedia resources, and collaborative learning technologies.

The findings contribute to existing discussions on ICT integration by highlighting a pattern that is often observed but less frequently documented at the institutional level: the presence of basic technological resources does not necessarily translate into a fully supportive digital learning environment. In this context, the study provides empirical evidence showing that teachers' readiness to integrate ICT may coexist with infrastructural limitations that constrain the practical implementation of technology-enhanced teaching. This insight expands current understanding of ICT adoption by suggesting that institutional readiness for Education 4.0 should be viewed not only in terms of teacher competencies but also in relation to the adequacy of the surrounding technological infrastructure.

Previous research has likewise emphasized that unstable internet connectivity and limited access to professional development programs can significantly hinder the effective integration of digital technologies in teaching (Organization for Economic Co-operation and Development, 2021; Tondeur et al., 2021). The present findings reinforce these observations while providing localized evidence from a higher education institution undergoing digital transformation. By documenting these infrastructural challenges alongside teachers' reported competencies, the study contributes a more comprehensive perspective on the institutional conditions necessary for advancing ICT integration in higher education.

Overall, the results suggest that although the institution has established certain foundational ICT resources, further improvements in connectivity, classroom technological infrastructure, and sustained professional development opportunities are needed to fully support transformative teaching practices associated with Education 4.0. Strengthening these institutional support systems will be essential in enabling educators to maximize the pedagogical potential of digital technologies and in ensuring that technological readiness is matched by an equally supportive institutional environment.

4.4. Teachers' Pedagogical Preparedness for Education 4.0

Table 5 presents the level of teachers' pedagogical preparedness for the implementation of Education 4.0. The overall weighted mean of 4.18 (Agree) indicates that respondents generally perceive themselves as ready to adopt teaching approaches that emphasize technology integration, learner-centered instruction, and the development of future-oriented competencies. This finding suggests that teachers are not only aware of the pedagogical shifts associated with digital transformation but are also willing to adapt their instructional practices to align with emerging educational paradigms.

Table 5: Teachers' Pedagogical Preparedness for Education 4.0

Pedagogical Integration	Total W	M_W	QI
I understand the principles of Education 4.0 (e.g., personalized learning, AI integration).	366	4.02	A
I am prepared to shift from traditional to student-centered, tech-enhanced instruction.	372	4.09	A
I incorporate 21st-century skills (e.g. collaboration, digital fluency) in my teaching.	381	4.19	A
I feel confident in adapting to emerging technologies in education	400	4.40	A
Overall Weighted Mean	380	4.18	A

Among the indicators, teachers expressed the highest level of agreement in their confidence to adapt to emerging educational technologies (WM = 4.40). This result highlights an important aspect of pedagogical readiness—teacher adaptability—which is widely recognized as a key factor in the successful implementation of innovative teaching practices. Previous studies have emphasized that educators' willingness to experiment with new technologies and instructional approaches plays a crucial role in enabling digital transformation in education (Scherer et al., 2021; Xu et al., 2024). The strong confidence expressed by respondents therefore suggests that teachers possess a positive orientation

toward pedagogical innovation, an essential characteristic in Education 4.0 learning environments.

Similarly, teachers reported actively incorporating 21st-century skills, such as collaboration and digital literacy, into their teaching practices. This reflects an awareness of the competencies required for learners to thrive in technology-driven societies and aligns with global frameworks promoting future-ready education. The integration of these competencies demonstrates that educators are beginning to move beyond traditional content delivery toward instructional approaches that emphasize active learning, collaboration, and problem-solving—core elements of Education 4.0 pedagogy (World Economic Forum, 2020).

Teachers also indicated readiness to transition from conventional teaching methods toward more student-centered and technology-enhanced instructional approaches. This shift is significant because Education 4.0 encourages teaching models that prioritize personalized learning experiences, collaborative knowledge construction, and interactive digital learning environments. The respondents' positive assessment in this area suggests that educators are gradually embracing pedagogical strategies consistent with constructivist and experiential learning perspectives, which have become central to contemporary digital education frameworks (Almeida & Simões, 2019; Kim & Bonk, 2021).

Although the indicator measuring teachers' understanding of Education 4.0 principles received the lowest mean score among the four indicators, it still falls within the "Agree" category. This result suggests that while teachers demonstrate readiness to implement technology-supported instructional strategies, their conceptual understanding of the broader theoretical foundations of Education 4.0—such as artificial intelligence integration, adaptive learning systems, and data-driven instructional design—may still require further strengthening. Previous research has similarly noted that educators often adopt technological tools in practice before fully developing a comprehensive understanding of the underlying educational frameworks guiding digital transformation (Organisation for Economic Co-operation and Development, 2021).

Taken together, the findings contribute to the growing body of research on Education 4.0 by providing empirical evidence that teachers within the institutional context demonstrate a generally high level of pedagogical readiness for technology-enhanced instruction. Importantly, the results suggest that educators are not resistant to pedagogical change; rather, they show openness, adaptability, and a willingness to incorporate digital and collaborative learning strategies. This insight challenges a common assumption in the literature that teacher resistance is a primary barrier to digital transformation in education.

The study therefore highlights an important implication for institutional policy and professional development. While teachers appear prepared to adopt Education 4.0 pedagogical practices, sustained professional development programs remain necessary to deepen their understanding of emerging technologies and advanced digital pedagogies. Strengthening these competencies will enable educators to move beyond basic

technology use toward more transformative instructional practices that fully leverage the potential of Education 4.0 learning environments.

4.5. Gaps and Challenges in ICT Adoption

Table 6 presents teachers' perceptions of the gaps and challenges associated with the adoption of ICT in teaching and learning. The overall weighted mean of 3.45, interpreted as Neutral, suggests that respondents neither strongly perceive nor strongly reject the presence of ICT-related challenges within the institution. This pattern indicates that while teachers acknowledge certain constraints, these barriers are not uniformly experienced or considered overwhelmingly severe. Instead, the results point to a transitional stage in ICT adoption, where technological integration is gradually progressing but continues to encounter several institutional and contextual limitations. Among the identified challenges, time constraints received the highest mean rating (WM = 3.65), indicating that teachers perceive limited time as the most significant barrier to effective ICT integration. This finding is particularly noteworthy because it shifts attention away from the commonly cited assumption that lack of technological skills is the primary obstacle to digital teaching. Instead, the results suggest that structural factors—such as teaching workload, lesson preparation, and administrative responsibilities—may play a more critical role in influencing teachers' ability to meaningfully integrate digital tools into their instructional practices. In this regard, the study contributes an important insight to the literature by highlighting how institutional and organizational demands can shape the practical implementation of ICT in the classroom.

Table 6: Gaps and Challenges in ICT Adoption

Gaps and Challenges	Total W	M_W	QI
I face challenges in assessing reliable ICT tools for teaching.	317	3.48	N
Time constraints limit my ability to integrate ICT effectively.	332	3.65	A
I lack sufficient training in using advanced digital tools.	317	3.49	N
Institutional policies support ICT integration in teaching and	316	3.47	N
Students are adequately equipped to engage with ICT - based instruction.	288	3.16	N
Overall Weighted Mean	380	4.18	A

Other indicators, including access to reliable ICT tools (WM = 3.48) and limited training in advanced digital technologies (WM = 3.49), received neutral ratings. These responses suggest that teachers' experiences with ICT resources and professional development opportunities vary across departments or instructional contexts. While some educators may already have sufficient access to technological tools and training programs, others may still encounter limitations that affect their capacity to integrate ICT effectively. The findings therefore point to uneven resource distribution and varying levels of exposure to professional development opportunities within the institution.

Similarly, institutional policy support for ICT integration obtained a neutral rating (WM = 3.47). This result implies that although policies promoting ICT integration may exist, their implementation may not yet be fully translated into consistent institutional practices, such as expanded training initiatives, adequate funding for technological resources, or sustained technical assistance. In many cases, institutional policies alone may not be

sufficient to encourage meaningful ICT integration unless they are accompanied by concrete support systems that enable teachers to apply digital technologies in their instructional work. The indicator with the lowest mean score relates to teachers' perceptions of students' preparedness for ICT-based instruction (WM = 3.16). Although still within the neutral range, this finding suggests emerging concerns regarding students' readiness to participate in technology-supported learning environments. Factors such as access to digital devices, internet connectivity, and students' own digital literacy skills may influence their ability to engage effectively in ICT-enhanced instruction. This observation highlights an important dimension of digital education: successful ICT integration depends not only on teacher competence and institutional infrastructure but also on the preparedness of learners themselves.

Taken together, the findings contribute to a more nuanced understanding of ICT adoption in higher education by demonstrating that the challenges associated with digital integration are multifaceted and systemic. Rather than being primarily driven by deficiencies in teacher competence, the results indicate that institutional workload structures, uneven resource access, policy implementation gaps, and student readiness all interact to influence the effectiveness of ICT integration in teaching and learning. By documenting these dynamics within the institutional context, the study provides empirical evidence that supports a more comprehensive perspective on the factors shaping Education 4.0 implementation. From a practical standpoint, these findings underscore the importance of strengthening institutional support mechanisms that enable educators to more effectively integrate digital technologies into their teaching. Addressing time constraints through workload adjustments, expanding access to advanced ICT training programs, improving technological infrastructure, and enhancing student digital preparedness may collectively contribute to a more supportive environment for ICT-enabled learning. Such initiatives are essential for ensuring that the growing competencies and pedagogical readiness of educators are matched by institutional conditions that fully support the goals of Education 4.0.

5. Conclusion

This study provides a comprehensive assessment of teachers' readiness to implement ICT integration within the framework of Education 4.0 at the Bicol State College of Applied Sciences and Technology (BISCAST). The findings reveal that educators possess generally strong competencies in digital literacy, ICT utilization, and pedagogical integration, indicating that the foundational skills necessary for technology-enhanced instruction are already well established. Moreover, the consistency observed across competency domains suggests a relatively uniform level of ICT readiness among faculty, reflecting institutional stability in capacity development rather than fragmented skill acquisition.

Equally significant is the high level of pedagogical preparedness demonstrated by teachers, particularly in adopting learner-centered approaches and integrating emerging technologies to foster 21st-century competencies. This readiness signals not only technical capability but also a progressive orientation toward innovative teaching practices aligned with the demands of Education 4.0.

Despite these strengths, the study underscores that effective ICT integration is constrained less by individual teacher competence and more by systemic and institutional factors. Limitations in infrastructure—particularly unreliable internet connectivity, insufficient ICT-equipped learning spaces, and restricted access to sustained professional

development—continue to impede full implementation. Most notably, time constraints and workload demands emerge as the most critical barriers, highlighting structural challenges that limit teachers' capacity to meaningfully engage with digital innovations.

Taken together, these findings reframe the discourse on ICT integration by shifting the focus from teacher deficiencies to broader institutional readiness. The results suggest that while human capital is largely in place, the enabling environment required to maximize its potential remains underdeveloped. This underscores the need for strategic, institution-wide interventions that go beyond skills training, including investments in infrastructure, the institutionalization of continuous professional development, and policies that address workload and time allocation.

Ultimately, advancing ICT integration in higher education requires a holistic approach that aligns teacher competencies with robust institutional support systems. Strengthening this alignment will be critical for realizing the transformative goals of Education 4.0 and ensuring that technological innovation translates into meaningful and sustainable improvements in teaching and learning.

Ethics Approval and Consent to Participate

The researcher used the ethical guidelines established by the Research office of the institution. This study was performed in accordance with the ethical standards of the institution. Informed consent was obtained from each participant as prescribed by Republic Act No. Republic Act No. 10173 (Data Privacy Act of 2012).

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Conflict of Interest

The author declares that there is no conflict of interest.

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