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Strategy empowerment for the enhancement of digital literacy in public higher education: A provincial case in China

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Abstract: This study aimed to address a critical gap by developing a strategic academic management strategy to systematically enhance digital literacy within public universities. Employing a sequential mixed-methods design, the research utilized a systematic SWOT analysis, collecting survey data from 190 academic leaders, to map internal capabilities against external influences. The analysis, detailed in the findings, identified Learning Media and Resources (PNImodified: 0.775) as the most significant overall internal weakness, particularly in digital awareness, while Measurement and Evaluation (PNImodified: 0.515) was the greatest strength. Externally, political factors (PNImodified: 0.541) emerged as the leading overall threat, contrasted by technological factors (PNImodified: 0.456) as the primary overall opportunity. These quantitative findings were systematically synthesized into a robust strategic quadrant matrix, which generated four essential strategic clusters SO, WO, ST, and WT to guide institutional action. The subsequent discussion elaborates on how this matrix facilitates the formulation of aggressive, turnaround, defensive, and cautious strategies, providing a contextually grounded and operationally actionable roadmap for academic leadership to proactively cultivate digitally literate graduates equipped for the modern workforce. Ultimately, the findings underscore the potential of academic management innovation to cultivate digitally competent graduates and strengthen institutional competitiveness in the era of rapid technological advancement.

Keywords: *Academic management, Curriculum development, Digital literacy, Educational innovation, Public higher education, Strategy development.*

1. Introduction

The advent of the digital age, driven by the pervasive integration of technologies such as cloud computing, 5G, big data, artificial intelligence (AI), and the Internet of Things (IoT), has fundamentally reshaped the demands placed on human capital [1, 2]. This transformation is compelling education systems worldwide to evolve, positioning digital literacy not as an ancillary competency but as a cornerstone of future-ready education [3]. Within this landscape, public universities in China are uniquely poised to lead the enhancement of digital literacy through strategically designed academic management frameworks, a critical initiative given the province's and the nation's broader push toward digital transformation [4, 5].

Digital literacy today encompasses a convergence of multiple literacies, forming a comprehensive and integrated skill set that extends far beyond basic computer skills [6, 7]. Information literacy enables individuals to locate, evaluate, and apply information effectively to address complex challenges [8]. Data literacy empowers individuals to leverage data-driven methodologies for accurate problem diagnosis and systematic optimization [9]. Meanwhile, artificial intelligence literacy equips learners to engage intelligently with automated systems, supporting personalized and adaptive educational experiences [10]. Together, these competencies reflect a growing need for higher-order cognitive, analytical, and ethical capabilities aligned with technological progress [11].

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In response, academic management strategies within higher education must evolve to embed digital literacy into the core of teaching, learning, and institutional development [12]. The ongoing digitization of China's education sector, especially in provinces like Henan, is part of a broader societal digital transformation. This dynamic reinforces the imperative for universities to produce not only digital natives but also proficient digital citizens: individuals endowed with the critical skills, knowledge, and ethical discernment required to excel in a digitally mediated world [13, 14]. Accordingly, the definition of core student competencies must explicitly incorporate digital literacy, guided by frameworks that emphasize technological fluency, socio-emotional intelligence in digital environments, and a human-centered approach to innovation [15, 16]. By embracing this mandate, public universities in Henan can act as catalysts for social modernization and economic growth, fostering a generation capable of creating value through empowered and responsible technology use [17].

This study offers a comprehensive review and empirical validation of the constituent elements of digital literacy and academic management. Using higher education institutions in selected provinces as a pilot context, it aims to develop a strategic academic management framework dedicated to enhancing digital literacy among students. The proposed framework is formulated through a systematic SWOT analysis, scrutinizing key internal factors including curriculum design, teaching methodologies, learning media/resources, and measurement and evaluation systems alongside critical external influences from the social, political, technological, and economic (PEST) environment [18, 19]. By synthesizing insights from this dual analysis, the strategy is designed to be both contextually grounded and operationally actionable, ensuring academic management practices are precisely aligned with the goal of cultivating digitally literate graduates equipped for the modern workforce [18].

2. Literature Review

2.1. The Strategic Imperative of Digital Transformation in Higher Education

The contemporary educational landscape is defined by the pervasive influence of the Fourth Industrial Revolution, driven by the convergence of cloud computing, Big Data, Artificial Intelligence (AI), and the Internet of Things (IoT) [20, 21]. This technological paradigm shift imposes unprecedented demands on human capital, compelling higher education institutions (HEIs) to move beyond incremental technological adoption toward a strategic digital transformation [22]. Strategic academic management in this era requires a holistic approach termed digital strategizing that fundamentally redesigns educational and administrative processes to enhance institutional agility and relevance [23]. Failure to adopt such a strategic posture risks obsolescence, as non-traditional digital education providers increasingly offer personalized and highly competitive alternatives [24]. Consequently, the development and enhancement of digital literacy in graduates has become a core strategic initiative, positioning it as a fundamental requirement for workforce readiness.

2.2. Defining Digital Literacy as a Multi-Domain Competency

Digital literacy is conceptualized in current scholarship as a complex, integrated meta-competency that far surpasses mere computer skills[25]. Academic frameworks synthesize this concept into several critical domains required for effective participation in digital society:

- Information and Data Literacy: This critical skill involves the ability to locate, evaluate for reliability, manage, and critically apply information derived from vast and often unstructured digital sources [24]. This is particularly challenging given the exponential growth of Big Data, demanding skills in interpreting and utilizing data analytics [26].
- Digital and Computational Thinking: This domain emphasizes a problem-solving approach wherein individuals formulate disciplinary problems and devise technology-aided solutions [26]. The focus shifts from mastering specific software tools to cultivating the cognitive capacity to adapt to and effectively utilize emerging technologies [26, 27].

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- Digital Social Responsibility and Ethics: This dimension addresses the crucial ethical and legal principles governing digital engagement. It includes awareness of intellectual property, data privacy, algorithmic bias, and the necessity of responsible online conduct to navigate the political and social risks inherent in digital platforms [28, 29].

2.3. The Impact of AI and Big Data on Academic Management Functions

The application of AI and Big Data is strategically reshaping two core academic management functions: curriculum development and measurement & evaluation.

In Curriculum Development, AI facilitates data-driven personalization [30]. Machine learning algorithms can analyze student performance data, learning styles, and real-time industry skill demands, allowing institutions to generate dynamic and responsive curricula. This capability is essential for closing the skill gap and ensuring that academic offerings remain aligned with the rapidly evolving needs of the modern workforce [31, 32].

For measurement and evaluation, AI significantly enhances efficiency by automating repetitive tasks (e.g., grading, scheduling) and providing predictive analytics that can identify at-risk students for proactive intervention [33]. However, this dependence on data introduces serious ethical concerns, notably regarding the potential for algorithmic bias, academic integrity challenges (e.g., generative AI misuse), and the essential need for strict data privacy protocols and human oversight [30, 34].

2.4. Strategic Planning Methodology

To systematically address these internal complexities and external pressures, HEIs must employ rigorous planning methodologies. The SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis remains a foundational tool for internal and external assessment [35].

This study utilizes the outputs of the SWOT analysis, particularly the quantitative prioritization provided by the Priority Needs Index (PNI), to construct a Strategic Quadrant Matrix. This matrix is the logical culmination of the assessment phase, providing a methodology for translating analytical findings into actionable management strategies:

- SO (Strengths-Opportunities): Defines an aggressive growth strategy.
- WO (Weaknesses-Opportunities): Prescribes a turnaround strategy to leverage external opportunities to overcome internal weaknesses.
- ST (Strengths-Threats): Mandates a defensive strategy to utilize existing internal capabilities to mitigate external risks.
- WT (Weaknesses-Threats): Determines a cautious or survival strategy focused on minimizing exposure and protecting critical resources [35, 36].

3. Research Design

This study adopted a sequential mixed-methods design [37] to examine and enhance academic management frameworks with a focus on digital-literacy integration. The inquiry progressed through three phases: (1) conceptual analysis to establish the theoretical foundation, (2) a situational SWOT assessment of current practices, and (3) development of evidence-based strategies. A census approach surveyed all public universities in the target province that offered international undergraduate programs and maintained a substantial international student population, ensuring adequate engagement with digital-literacy demands. Within each institution, stratified purposive sampling selected five key academic leaders one vice-president, one academic-affairs director, and three deans, capturing strategic, operational, and disciplinary perspectives. The final sample comprised 190 respondents, sufficient to achieve a 5% margin of error at the 95% confidence level.

Data were collected through a structured online questionnaire comprising demographic items, a dual-response gap analysis of current versus desired digital-literacy practices, and an assessment of external factors (political-legal, economic, socio-cultural, and technological). Responses used a five-point

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Likert scale. Expert review and pilot testing confirmed content validity, and reliability was high [38] (Cronbach's $\alpha = 0.845$). Participation was voluntary and anonymous, with institutional approval (protocol code 053/2566-201/2567) and informed consent obtained before distribution via Wenjuanxing. Quantitative analysis employed descriptive statistics and the Priority Needs Index ($PNI_{modified}$), calculated as $(I - D)/D$, where I represents the desired state and D the current level; higher scores indicated greater need. $PNI_{modified}$ results guided the SWOT classification of strengths, weaknesses, opportunities, and threats, forming the empirical basis for the final strategic recommendations.

4. Finding

4.1. Internal Environment Analysis (Strengths and Weaknesses)

The analysis of the academic management's internal environment, synthesized using the modified Priority Needs Index ($PNI_{modified}$) (as presented in

Table), reveals key areas of strength and weakness concerning digital literacy enhancement. The most significant overall weakness identified within the current academic system is associated with Learning Media and Resources, registering a $PNI_{modified}$ of 0.775. This deficiency is particularly acute in the enhancement of digital awareness ($PNI_{modified}$: 1.065) and digital communication and collaboration ($PNI_{modified}$: 0.969) within this component. Furthermore, Curriculum Development is also categorized as an overall weakness ($PNI_{modified}$: 0.569), driven primarily by the high need for improvement in digital and computational thinking ($PNI_{modified}$: 0.790). Critically, the single most urgent specific weakness across all internal factors is found in the Measurement and Evaluation component for enhancing digital social responsibility, which reported the highest $PNI_{modified}$ value of 1.266.

In contrast, the overall greatest strength of the academic management system is lodged in Measurement and Evaluation ($PNI_{modified}$: 0.515). Sub-factors contributing to this strength include digital communication and collaboration ($PNI_{modified}$: 0.306), digital and computational thinking ($PNI_{modified}$: 0.338), and digital awareness ($PNI_{modified}$: 0.348). Other internal components, Teaching and Learning ($PNI_{modified}$: 0.567) and Curriculum Development ($PNI_{modified}$: 0.569), are also categorized as overall strengths, suggesting they possess a foundational capacity, particularly in areas like digital communication and collaboration and digital knowledge and skills, that can be leveraged for strategic intervention.

4.2. External Environment Analysis (Opportunities and Threats)

The assessment of the external environment, detailed in Table , highlights the opportunities and threats that significantly impact the enhancement of digital literacy. The primary overall threat is posed by political factors ($PNI_{modified}$: 0.541). This political environment presents a particularly severe threat to the teaching and learning component, specifically with respect to digital social responsibility ($PNI_{modified}$: 1.330) and digital communication and collaboration ($PNI_{modified}$: 0.89). Additionally, economic factors constitute the second-highest overall threat ($PNI_{modified}$: 0.488). The economic landscape critically endangers the curriculum development component, most notably in the sub-factors of digital communication and collaboration ($PNI_{modified}$: 1.200) and digital awareness ($PNI_{modified}$: 0.969). Social and cultural factors ($PNI_{modified}$: 0.474) also introduce threats, primarily against learning media and resources, concerning digital awareness ($PNI_{modified}$: 0.977).

Conversely, the most substantial overall opportunity for enhancing digital literacy originates from technological factors ($PNI_{modified}$: 0.456). This technological leverage offers the strongest specific opportunity for teaching and learning in the area of digital and computational thinking ($PNI_{modified}$: 0.0863). Favorable technological factors also present significant opportunities across measurement and evaluation ($PNI_{modified}$: 0.419), curriculum development ($PNI_{modified}$: 0.508), and learning media and resources ($PNI_{modified}$: 0.631) components. Finally, social and cultural factors ($PNI_{modified}$: 0.474) are

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identified as a notable opportunity, particularly in strengthening digital communication and collaboration within teaching and learning ($PNI_{modified}$: 0.173).

The strategic framework was developed by systematically integrating the critical internal factors (Strengths and Weaknesses from

Table) with the external factors (Opportunities and Threats from Table) through a strategic quadrant matrix. This integration resulted in four distinct clusters of strategic initiatives designed to provide a balanced and targeted institutional response:

1. SO (Strengths-Opportunities) Strategy: This Max-Max approach emphasizes an aggressive posture by leveraging the institutional strength in measurement and evaluation to maximize the technological opportunity ($PNI_{modified}$: 0.456). The strategy dictates the rapid adoption of emerging educational technologies, supported by existing strong evaluation mechanisms, to aggressively develop advanced digital and computational thinking skills.
2. WO (Weaknesses-Opportunities) Strategy: This Min-Max approach focuses on turnaround. This critical cluster addresses the most urgent overall internal deficiency, the Weakness in Learning Media and Resources ($PNI_{modified}$: 0.775), by prioritizing the exploitation of the dominant Technological Opportunity. Strategic initiatives here include immediate investment in advanced digital platforms and resources to mitigate deficits in digital awareness and communication, effectively using the external environment to resolve internal systemic deficits.
3. ST (Strengths-Threats) Strategy: This Max-Min approach acts as a defensive strategy. It utilizes the existing Strength in Measurement and Evaluation to mitigate the significant Threat posed by Political factors ($PNI_{modified}$: 0.541). The strategy involves developing robust, evidence-based performance metrics for digital literacy programs to justify their continued existence, resource allocation, and efficacy against external political pressures, particularly those targeting teaching practices and digital social responsibility.
4. WT (Weaknesses-Threats) Strategy: This Min-Min approach employs a cautious strategy, prioritizing risk mitigation. It addresses the simultaneous challenge of the weakness in learning media and the dominant political threat. Strategic actions center on resource protection and conservative planning, focusing on essential compliance and risk aversion in areas where internal weaknesses intersect with high external vulnerability, ensuring institutional stability while the other strategies drive growth and turnaround.

Table 1.
Analysis of the Academic Management Components.

Academic Management for public universities to enhance digital literacy	Internal environment (Overall)							
	Current State		Desirable State		Priority Needs		High/ Low Group	SWOT Result
	M	Std.	M	Std.	$PNI_{modified}$	Rank		
Curriculum Development	3.0516	.55822	4.6558	0.20585	0.5687	2	Low	S
Digital awareness	3.37	1.326	4.78	0.416	0.4187	4	Low	S
Digital communication and collaboration	3.38	1.143	4.77	0.420	0.4112	5	Low	S
Digital and computational thinking	2.57	1.430	4.60	0.491	0.7907	1	High	W
Digital knowledge and skills	3.29	1.087	4.81	0.397	0.4620	3	Low	S
Digital social responsibility	2.64	.959	4.32	0.468	0.6364	2	High	W
Teaching and Learning	3.0358	.55012	4.6242	0.20064	0.5668	3	Low	S
Digital awareness	2.80	1.004	4.54	0.500	0.6214	1	High	W
Digital communication and collaboration	3.25	1.451	4.73	0.447	0.4554	5	Low	S

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	Current State		Desirable State		Priority Needs		High/ Low Group	SWOT Result
	M	Std.	M	Std.	$PNI_{modified}$	Rank		
Digital and computational thinking	3.12	1.314	4.63	0.484	0.4830	4	Low	S
Digital knowledge and skills	3.14	1.415	4.70	0.459	0.4968	3	Low	S
Digital social responsibility	2.87	1.352	4.53	0.501	0.5780	2	High	W
Learning Media and Resources	2.6895	.61152	4.5463	0.20641	0.7749	1	High	W
Digital awareness	2.19	1.211	4.52	0.501	1.0648	1	High	W
Digital communication and collaboration	2.29	1.347	4.51	0.501	.9694	2	High	W
Digital and computational thinking	3.53	1.167	4.80	0.401	0.3595	5	Low	S
Digital knowledge and skills	2.77	1.386	4.37	0.485	0.5773	4	High	W
Digital social responsibility	2.66	1.611	4.53	0.500	0.7045	3	High	W
Measurement and Evaluation	3.1284	.58367	4.5968	0.18341	0.5145	4	Low	S
Digital awareness	3.64	1.059	4.91	0.294	0.3479	3	Low	S
Digital communication and collaboration	3.67	1.333	4.79	0.409	0.3057	5	Low	S
Digital and computational thinking	3.56	1.378	4.76	0.426	0.3371	4	Low	S
Digital knowledge and skills	2.93	1.509	4.36	0.481	0.4870	2	Low	S
Digital social responsibility	1.84	1.226	4.17	0.375	1.2663	1	High	W

Note: S: Strength, W: Weakness; Midrange value of four components of academic management: (0.7749+0.5145)/2 = 0.6447, higher than 0.6447 is categorized in W, on the contrary, S.

Table 2.
Analysis of the External Environment Impacting the Implementation of the Academic Management.

Academic Management for the public to enhance digital literacy	External environment (Overall)							
	Current State		Desirable State		Priority Needs		High/ Low Group	SWOT Result
	M	Std.	M	Std.	$PNI_{modified}$	Rank		
Political factor	3.0071	0.28357	4.6345	0.09831	0.5413	1	High	T
Curriculum Development	3.2811	0.63007	4.6695	0.18916	0.4232	4	Low	O
Digital awareness	3.55	1.042	4.76	0.429	0.3408	4	Low	O
Digital communication and collaboration	3.47	1.486	4.71	0.455	0.3573	3	Low	O
Digital and computational thinking	3.82	1.227	4.86	0.345	0.2723	5	Low	O
Digital knowledge and skills	2.19	1.443	4.30	0.459	0.9635	1	High	T
Digital social responsibility	3.38	1.513	4.72	0.452	0.3964	2	Low	O
Teaching and learning	2.5979	.60193	4.4874	0.20302	0.7273	1	High	T
Digital awareness	2.63	1.527	4.54	0.500	0.7262	3	Low	O
Digital communication and collaboration	2.31	1.396	4.36	0.482	0.8874	2	High	T
Digital and computational thinking	2.89	1.550	4.58	0.495	0.5848	4	Low	O
Digital knowledge and skills	3.37	1.314	4.79	0.409	0.4214	5	Low	O
Digital social responsibility	1.79	1.129	4.17	0.375	1.3296	1	High	T
Learning Media and Resources	3.0400	.48171	4.7305	0.17522	0.5563	2	Low	O
Digital awareness	3.11	1.064	4.79	0.409	0.5408	4	High	T
Digital communication and collaboration	3.47	1.413	4.72	0.450	0.3602	5	High	T
Digital and computational thinking	2.69	1.274	4.48	0.501	0.6654	1	High	T

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	Current State		Desirable State		Priority Needs		High/ Low Group	SWOT Result
	M	Std.	M	Std.	$PNI_{modified}$	Rank		
Digital knowledge and skills	2.96	1.121	4.79	0.405	0.6182	3	High	T
Digital social responsibility	2.97	.863	4.86	0.345	0.6364	2	High	T
Measurement and Evaluation	3.1095	.52354	4.6505	0.19293	0.4952	3	Low	O
Digital awareness	3.28	1.249	4.75	0.436	0.4482	4	Low	O
Digital communication and collaboration	2.84	1.229	4.41	0.493	0.5528	3	High	T
Digital and computational thinking	2.99	1.357	4.66	0.474	0.5585	2	High	T
Digital knowledge and skills	2.61	1.576	4.52	0.501	0.7318	1	High	T
Digital social responsibility	3.82	.810	4.92	0.278	0.2879	5	Low	O
Economic factor	3.1063	.28934	4.6208	0.10339	0.4876	2	Low	O
Curriculum Development	2.6147	.67062	4.4611	0.24094	0.7062	1	High	T
Digital awareness	2.25	1.394	4.43	0.497	0.9689	2	High	T
Digital communication and collaboration	1.95	1.375	4.29	0.457	1.2000	1	High	T
Digital and computational thinking	3.19	1.616	4.51	0.501	0.4138	5	Low	O
Digital knowledge and skills	2.57	1.434	4.38	0.488	0.7043	3	Low	O
Digital social responsibility	3.12	1.163	4.69	0.464	0.5032	4	Low	O
Teaching and learning	3.2937	.57484	4.6274	0.19542	0.4053	3	Low	O
Digital awareness	3.89	1.527	4.74	0.439	0.2185	5	Low	O
Digital communication and collaboration	2.93	1.339	4.47	0.500	0.5256	2	High	T
Digital and computational thinking	2.47	1.320	4.48	0.501	0.8138	1	High	T
Digital knowledge and skills	3.67	1.418	4.78	0.416	0.3025	4	Low	O
Digital social responsibility	3.51	1.288	4.66	0.474	0.3276	3	Low	O
Learning Media and Resources	3.5316	.53507	4.8063	0.17446	0.3610	4	Low	O
Digital awareness	3.32	1.120	4.75	0.436	0.4307	3	High	T
Digital communication and collaboration	3.21	1.548	4.72	0.452	0.4704	2	High	T
Digital and computational thinking	3.46	1.001	4.77	0.423	0.3786	4	High	T
Digital knowledge and skills	4.44	1.303	4.88	0.327	0.0991	5	Low	O
Digital social responsibility	3.23	.829	4.92	0.270	0.5232	1	High	T
Measurement and Evaluation	2.9853	.56736	4.5884	0.21200	0.5374	2	High	T
Digital awareness	3.06	1.239	4.62	0.486	0.5098	4	High	T
Digital communication and collaboration	2.68	1.371	4.51	0.501	0.6828	2	High	T
Digital and computational thinking	2.76	1.089	4.56	0.497	0.6522	3	High	T
Digital knowledge and skills	2.46	1.562	4.43	0.497	0.8008	1	High	T
Digital social responsibility	3.96	1.303	4.82	0.384	0.2172	5	Low	O
Social and Cultural factors	3.1350	.29466	4.6218	0.09710	0.4743	3	Low	O
Curriculum Development	3.1074	.58829	4.6453	0.20536	0.4945	2	High	T
Digital awareness	2.92	1.633	4.57	0.496	0.5651	2	High	T
Digital communication and collaboration	3.46	.957	4.73	0.444	0.3671	5	Low	O
Digital and computational thinking	2.91	1.009	4.72	0.450	0.6220	1	High	T
Digital knowledge and skills	3.05	1.225	4.56	0.497	0.4951	3	High	T
Digital social responsibility	3.19	1.629	4.64	0.482	0.4545	4	Low	O
Teaching and learning	3.4126	.58323	4.6674	0.17117	0.3677	4	Low	O
Digital awareness	2.82	1.662	4.56	0.498	0.6170	2	High	T
Digital communication and	4.16	1.136	4.88	0.327	0.1731	5	Low	O

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	M	Std.	M	Std.	$PNI_{modified}$	Rank		
collaboration								
Digital and computational thinking	3.71	1.343	4.81	0.397	0.2965	3	Low	O
Digital knowledge and skills	2.47	1.135	4.20	0.401	0.7004	1	High	T
Digital social responsibility	3.89	1.255	4.89	0.308	0.2571	4	Low	O
Learning Media and Resources	2.8747	0.52984	4.5958	0.19943	0.5987	1	High	T
Digital awareness	2.15	1.213	4.25	0.433	0.9767	1	High	T
Digital communication and collaboration	3.49	1.242	4.80	0.401	0.3754	5	Low	O
Digital and computational thinking	3.08	1.004	4.65	0.477	0.5097	4	Low	O
Digital knowledge and skills	2.55	1.303	4.58	0.494	0.7961	2	High	
Digital social responsibility	3.10	1.324	4.69	0.462	0.5129	3	Low	O
Measurement and Evaluation	3.1453	.56452	4.5789	0.18962	0.4557	3	Low	O
Digital awareness	3.58	1.146	4.89	0.308	0.3660	4	Low	O
Digital communication and collaboration	3.31	1.256	4.70	0.459	0.4199	3	Low	O
Digital and computational thinking	3.90	1.442	4.74	0.439	0.2154	5	Low	O
Digital knowledge and skills	2.49	1.352	4.22	0.416	0.6948	2	High	T
Digital social responsibility	2.45	1.412	4.34	0.474	0.7714	1	High	T
Technological factor	3.1518	.26664	4.6174	0.09739	0.4650	4	Low	O
Curriculum Development	3.0379	.54105	4.5768	0.19597	0.5076	2	High	T
Digital awareness	2.97	1.329	4.67	0.470	0.5724	3	High	T
Digital communication and collaboration	2.46	.912	4.40	0.491	0.7886	1	High	T
Digital and computational thinking	3.38	1.382	4.58	0.494	0.3550	4	Low	O
Digital knowledge and skills	2.77	1.037	4.45	0.499	0.6065	2	High	T
Digital social responsibility	3.61	1.493	4.77	0.420	0.3213	5	Low	O
Teaching and learning	3.5053	.57778	4.7032	0.19379	0.3417	4	Low	O
Digital awareness	2.97	1.266	4.50	0.501	0.5152	1	High	T
Digital communication and collaboration	3.18	1.330	4.63	0.485	0.4560	3	High	T
Digital and computational thinking	4.52	1.198	4.91	0.294	0.0863	5	Low	O
Digital knowledge and skills	3.12	1.672	4.63	0.485	0.4840	2	High	T
Digital social responsibility	3.73	.963	4.86	0.350	0.3029	4	high	T
Learning Media and Resources	2.7621	.61879	4.5042	0.20850	0.6307	1	High	T
Digital awareness	2.65	1.449	4.45	0.499	0.6792	4	High	T
Digital communication and collaboration	2.56	1.434	4.55	0.499	0.7773	1	High	T
Digital and computational thinking	3.37	1.659	4.56	0.498	0.3531	5	Low	O
Digital knowledge and skills	2.63	1.594	4.43	0.496	0.6844	3	High	T
Digital social responsibility	2.60	.872	4.54	0.500	0.7462	2	High	T
Measurement and Evaluation	3.3021	.53402	4.6853	0.18770	0.4187	3	Low	O
Digital awareness	3.43	1.445	4.53	0.501	0.3207	5	Low	O
Digital communication and collaboration	3.55	1.219	4.86	0.350	0.3690	3	Low	O
Digital and computational thinking	3.60	1.028	4.79	0.405	0.3306	4	Low	O
Digital knowledge and skills	3.46	.871	4.92	0.270	0.4220	2	Low	O
Digital social responsibility	2.47	1.207	4.33	0.470	0.7530	1	High	T

Note: T: Threads, O: Opportunity.

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Table 3.
Conclusion of the Strengths and Weaknesses of the Academic Management.

Strength-S ($PNI_{modified}$)	**Weakness-W ($PNI_{modified}$)**
S1 Measurement and Evaluation (.515)	W1 Learning Media and Resources (.775)
S11 Measurement and evaluation in enhancing *digital communication and collaboration (.306)*	W11 Learning Media and Resources in enhancing *digital awareness (1.065)*
S12 Measurement and evaluation in enhancing *digital and computational thinking (.338)*	W12 Learning Media and Resources in enhancing *digital communication and collaboration (.969)*
S13 Measurement and evaluation in enhancing *digital awareness (.348)*	W13 Learning Media and Resources in enhancing *digital social responsibility (.705)*
S14 Measurement and evaluation in enhancing *digital knowledge and skills (.487)*	W14 Learning Media and Resources in enhancing *digital knowledge and skills (.577)*
S2 Teaching and learning (.567)	W2 Curriculum Development (.569)
S21 Teaching and learning in enhancing *digital communication and collaboration (.455)*	W21 Curriculum Development in enhancing *digital and computational thinking (.790)*
S22 Teaching and learning in enhancing *digital and computational thinking (.483)*	W22 Curriculum Development in enhancing *digital social responsibility (.636)*
S23 Teaching and learning in enhancing *digital knowledge and skills (.497)*	W3 Teaching and learning (.567)
S3 Curriculum Development (.569)	W31 Teaching and learning in enhancing Digital awareness *(.621)*
S31Curriculum Development in enhancing *digital communication and collaboration (.411)*	W32 Teaching and learning in enhancing Digital social responsibility *(.578)*
S32 Curriculum Development in enhancing *digital awareness (.419)*	W4 Measurement and Evaluation (.515)
S33 Curriculum Development in enhancing *digital knowledge and skills (.462)*	W41 Measurement and evaluation in enhancing digital social responsibility *(1.266)*
S4 Learning Media and Resources (.775)	
S41 Learning Media and Resources in enhancing *digital and computational thinking (.360)*	

Table 4.
Conclusion of the Opportunities and Threats Concerning the External Environment.

Opportunities-O ($PNI_{modified}$)	**Threads-T ($PNI_{modified}$)**
O1 Technological factor (.456)	T1 Political factors (.541)
O11Teaching and learning (.342)	T11 Teaching and learning (.727)
O111 Technological factors enable teaching and learning to enhance digital literacy concerning *digital and computational thinking* (.863)	T111 Political factors threaten teaching and learning to enhance digital literacy concerning *digital social responsibility* (1.330)
O12 Measurement and Evaluation (.419)	T112 Political factors threaten teaching and learning to enhance digital literacy concerning *digital communication and collaboration* (.89)
O121 Technological factors enable measurement and evaluation to enhance digital literacy concerning *digital awareness* (.321)	T12 Learning Media and Resources (.556)
O122 Technological factors enable measurement and evaluation to enhance digital literacy concerning *digital and computational thinking* (.331)	T121 Political factors threaten Learning Media and Resources to enhance digital literacy concerning *digital and computational thinking* (.665)
O123 Technological factors enable measurement and evaluation to enhance digital literacy concerning *digital communication and collaboration* (.370)	T122 Political factors threaten Learning Media and Resources to enhance digital literacy concerning d*igital social responsibility* (.636)
O124 Technological factors enable measurement and evaluation to enhance digital literacy concerning *digital knowledge and skills* (.422)	T123 Political factors threaten Learning Media and Resources to enhance digital literacy concerning *digital knowledge and skills* (.618)
O13 Curriculum Development (.508)	T124 Political factors threaten Learning Media and Resources to enhance digital literacy concerning d*igital awareness* (.541)
O131 Technological factors enable curriculum development to enhance digital literacy concerning *digital social responsibility* (.321)	T125 Political factors threaten Learning Media and Resources to enhance digital literacy concerning *digital*
O132 Technological factors enable curriculum development to	

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Opportunities-O ($PNI_{modified}$)	**Threads-T ($PNI_{modified}$)**
enhance digital literacy concerning *digital and computational thinking* (.355) O14 Learning Media and Resources (.631) O141 Technological factors enable Learning Media and Resources to enhance digital literacy concerning *digital and computational thinking* (.353)	*communication and collaboration* (.360) T13 Measurement and Evaluation (.495) T131 Political factors threaten measurement and evaluation to enhance digital literacy concerning *digital knowledge and skills* (.732) T132 Political factors threaten measurement and evaluation to enhance digital literacy concerning d*igital and computational thinking* (.559) T133 Political factors threaten measurement and evaluation to enhance digital literacy concerning d*igital communication and collaboration* (.553) T14 Curriculum Development (.423) T141 Political factors threaten curriculum development to enhance digital literacy concerning d*igital knowledge and skills* (.964)
O2 Social and Cultural factor (.474) O21 Teaching and learning (.368) O211 Social and Cultural factors enable teaching and learning to enhance digital literacy concerning *digital communication and collaboration* (.173) O212 Social and Cultural factors enable teaching and learning to enhance digital literacy concerning *digital social responsibility* (.257) O213 Social and Cultural factors enable teaching and learning to enhance digital literacy concerning *digital and computational thinking* (.297) O22 Measurement and Evaluation (.456) O221 Social and Cultural factors enable measurement and evaluation to enhance digital literacy concerning *digital and computational thinking* (.215) O222 Social and Cultural factors enable measurement and evaluation to enhance digital literacy concerning *digital awareness* (.366) O223 Social and Cultural factors enable measurement and evaluation to enhance digital literacy concerning *digital communication and collaboration* (.420) O23 Curriculum Development (.495) O231 Social and Cultural factors enable curriculum development to enhance digital literacy concerning *digital communication and collaboration* (.367) O232 Social and Cultural factors enable curriculum development to enhance digital literacy concerning *digital social responsibility* (.455) O24 Learning Media and Resources (.599) O241 Social and Cultural factors enable Learning Media and Resources to enhance digital literacy concerning *digital communication and collaboration* (.375) O242 Social and Cultural factors enable Learning Media and Resources to enhance digital literacy concerning d*igital and computational thinking* (.510) O243 Social and Cultural factors enable Learning Media and Resources to enhance digital literacy concerning *digital social responsibility* (.513)	T2 Economic factors (.488) T21 Curriculum Development (.706) T211 Economic factors threaten curriculum development to enhance digital literacy concerning d*igital communication and collaboration* (1.2) T212 Economic factors threaten curriculum development to enhance digital literacy concerning d*igital awareness* (.969) T22 Measurement and Evaluation (.537) T221 Economic factors threaten measurement and evaluation to enhance digital literacy concerning *digital knowledge and skills* (.801) T222 Economic factors threaten measurement and evaluation to enhance digital literacy concerning d*igital communication and collaboration* (.683) T223 Economic factors threaten measurement and evaluation to enhance digital literacy concerning *digital and computational thinking* (.652) T23 Teaching and learning (.405) T231 Economic factors threaten teaching and learning to enhance digital literacy concerning *digital and computational thinking* (.814) T232 Economic factors threaten teaching and learning to enhance digital literacy concerning *digital communication and collaboration* (.526) T24 Learning Media and Resources (.361) T241 Economic factors threaten Learning Media and Resources to enhance digital literacy concerning *digital social responsibility* (.523) T242 Economic factors threaten Learning Media and Resources to enhance digital literacy concerning *digital communication and collaboration* (.470) T243 Economic factors threaten Learning Media and Resources to enhance digital literacy concerning *digital awareness* (.431) T244 Economic factors threaten Learning Media and Resources to enhance digital literacy concerning *digital and computational thinking* (.379)
O3 Economic factors (.488) O31 Learning Media and Resources (.361) O311 Economic factors enable Learning Media and Resources to enhance digital literacy concerning *digital knowledge and skills* (.099)	T3 Social and Cultural factors (.474) T31 Learning Media and Resources (.599) T311 Social and cultural factors threaten Learning Media and Resources to enhance digital literacy concerning *digital awareness* (.977)

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Opportunities-O ($PNI_{modified}$)	**Threads-T ($PNI_{modified}$)**
O32 Teaching and learning (.405) O321 Economic factors enable teaching and learning to enhance digital literacy concerning *digital awareness* (.218) O322 Economic factors enable teaching and learning to enhance digital literacy concerning d*igital knowledge and skills* (.303) O323 Economic factors enable teaching and learning to enhance digital literacy concerning *digital social responsibility* (.328) O33 Measurement and Evaluation (.537) O331 Economic factors enable measurement and evaluation to enhance digital literacy concerning *digital social responsibility* (.217) O34 Curriculum Development (.706) O341 Economic factors enable curriculum development to enhance digital literacy concerning *digital and computational thinking* (.414) O342 Economic factors enable curriculum development to enhance digital literacy concerning *digital social responsibility* (.503) O343 Economic factors enable curriculum development to enhance digital literacy concerning d*igital knowledge and skills* (.704)	T312 Social and cultural factors threaten Learning Media and Resources to enhance digital literacy concerning d*igital knowledge and skills* (.796) T32 Curriculum Development (.495) T321 Social and cultural factors threaten curriculum development to enhance digital literacy concerning *digital and computational thinking* (.622) T322 Social and cultural factors threaten curriculum development to enhance digital literacy concerning *digital awareness* (.565) T323 Social and cultural factors threaten curriculum development to enhance digital literacy concerning *digital knowledge and skills* (.495) T33 Measurement and Evaluation (.456) T331 Social and cultural factors threaten measurement and evaluation to enhance digital literacy concerning *digital social responsibility* (.771) T332 Social and cultural factors threaten measurement and evaluation to enhance digital literacy, *digital knowledge, and skills* (.695) T34 Teaching and learning (.368) T341 Social and cultural factors threaten teaching and learning to enhance digital literacy concerning *digital knowledge and skills* (.700) T342 Social and cultural factors threaten teaching and learning to enhance digital literacy concerning *digital awareness* (.617)
O4 Political factors (.541) O41 Curriculum Development (.4232) O411 Political factors enable curriculum development to enhance digital literacy concerning *digital and computational thinking* (.272) O412 Political factors enable curriculum development to enhance digital literacy concerning *digital awareness* (.341) O413 Political factors enable curriculum development to enhance digital literacy concerning *digital communication and collaboration* (.357) O414 Political factors enable curriculum development to enhance digital literacy concerning *digital social responsibility* (.396) O42 Measurement and Evaluation (.495) O421 Political factors enable measurement and evaluation to enhance digital literacy concerning *digital social responsibility* (.288) O422 Political factors enable measurement and evaluation to enhance digital literacy concerning Digital awareness (.448) O43 Teaching and learning (.727) O431 Political factors enable teaching and learning to enhance digital literacy concerning *digital knowledge and skills* (.585) O432 Political factors enable teaching and learning to enhance digital literacy concerning digital and computational thinking (.421)	T4 Technological factors (.456) T41 Learning Media and Resources (.631) T411 Technological factors threaten Learning Media and Resources to enhance digital literacy concerning *digital communication and collaboration* (.777) T412 Technological factors threaten Learning Media and Resources to enhance digital literacy concerning *digital social responsibility* (.746) T413 Technological factors threaten Learning Media and Resources to enhance digital literacy concerning *digital knowledge and skills* (.684) T414 Technological factors threaten Learning Media and Resources to enhance digital literacy concerning *Digital awareness* (.679) T42 Curriculum Development (.508) T421 Technological factors threaten curriculum development to enhance digital literacy concerning *digital communication and collaboration* (.789) T422 Technological factors threaten curriculum development to enhance digital literacy concerning *digital knowledge and skills* (.607) T423 Technological factors threaten curriculum development to enhance digital literacy concerning *digital awareness* (.572) T43 Measurement and Evaluation (.419) T431 Technological factors threaten measurement and evaluation to enhance digital literacy concerning *digital social responsibility* (.753) T43 Teaching and learning (.342) T431 Technological factors threaten teaching and learning to enhance digital literacy concerning *digital awareness* (.515) T432 Technological factors threaten teaching and learning

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Opportunities-O ($PNI_{modified}$)	Threads-T ($PNI_{modified}$)
	to enhance digital literacy concerning *digital knowledge and skills* (.484) T433 Technological factors threaten teaching and learning to enhance digital literacy concerning *digital communication and collaboration* (.456) T434 Technological factors threaten teaching and learning to enhance digital literacy concerning *digital social responsibility* (.303)

Table 5.
TOWS Matrix (Measurement and Evaluation-External Factors).

Academic Management of Public Universities to Enhance the Digital Literacy	**TOWS Matrix**
Measurement and Evaluation (.515) S11 Measurement and evaluation in enhancing *digital communication and collaboration (.306)* S12 Measurement and evaluation in enhancing *digital and computational thinking (.338)* S13 Measurement and evaluation in enhancing *digital awareness (.348)* S14 Measurement and evaluation in enhancing *digital knowledge and skills (.487)*	Strength-Opportunity (SO): Use strengths to maximize opportunities
	S1O1 Technological factors enable measurement and evaluation to enhance digital literacy concerning: S1O121 *digital awareness* (.348) S1O122 *digital and computational thinking* (.338) S1O123 *digital communication and collaboration* (.306) S1O124 *digital knowledge and skills* (.487)
	S1O2 Social and Cultural factors enable measurement and evaluation to enhance digital literacy concerning: S1O221 *digital and computational thinking* (.338) S1O222 *digital awareness* (.348) S1O223 *digital communication and collaboration* (.306)
	S1O4 Political factors enable measurement and evaluation to enhance digital literacy concerning S1O421 *digital awareness* (.348)
	Strength-Threats (ST): Use strengths to reduce threats
	S1T1 Political factors threaten measurement and evaluation to enhance digital literacy concerning: S1T131 *digital knowledge and skills* (.487) S1T132 d*igital and computational thinking* (.338) S1T133 d*igital communication and collaboration* (.306)
	S1T2 Economic factors threaten measurement and evaluation to enhance digital literacy concerning: S1T221 *digital knowledge and skills* (.487) S1T222 d*igital communication and collaboration* (.306) S1T223 *digital and computational thinking* (.338)
	S1T3 Social and cultural factors threaten measurement and evaluation to enhance digital literacy, concerning: S1T332 *digital knowledge and skills* (.487)
W4 Measurement and Evaluation (.515) W41 Measurement and evaluation in enhancing digital social responsibility *(1.266)*	Weakness-Opportunity (WO): Reduce weaknesses to develop opportunities
	W4O3 Economic factors enable measurement and evaluation to enhance digital literacy concerning: W41 digital social responsibility *(1.266)*
	W4O4 Political factors enable measurement and evaluation to enhance digital literacy concerning:

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Academic Management of Public Universities to Enhance the Digital Literacy	TOWS Matrix
	W41 digital social responsibility *(1.266)*
	Weaknesses-Threat (WT): Avoid threats by reducing weaknesses
	W4T3 Social and cultural factors threaten measurement and evaluation to enhance digital literacy concerning: W41 digital social responsibility *(1.266)*
	W4T4 Technological factors threaten measurement and evaluation to enhance digital literacy concerning: W41 digital social responsibility *(1.266)*

Table 6.
TOWS Matrix (Teaching and Learning-External Factors).

Academic Management of Public Universities to Enhance the Digital Literacy	TOWS Matrix
Teaching and learning (.567) S21 Teaching and learning in enhancing *digital communication and collaboration (.455)* S22 Teaching and learning in enhancing *digital and computational thinking (.483)* S23 Teaching and learning in enhancing *digital knowledge and skills (.497)*	Strength-Opportunity (SO): Use strengths to maximize opportunities
	S2O1 Technological factors enable teaching and learning to enhance digital literacy concerning: S2O111 *digital and computational thinking* (.483)
	S2O2 Social and Cultural factors enable teaching and learning to enhance digital literacy concerning: S2O211 *digital communication and collaboration* (.173) S2O212 *digital social responsibility* (.257) S2O213 *digital and computational thinking* (.297)
	S2O3 Economic factors enable teaching and learning to enhance digital literacy concerning: S2O311 *digital awareness* (.218) S2O311 d*igital knowledge and skills* (.303) S2O311 *digital social responsibility* (.328)
	S2O4 Political factors enable teaching and learning to enhance digital literacy concerning: S2O431 *digital knowledge and skills* (.585) S2O432 *digital and computational thinking* (.421)
	Strength-Threats (ST): Use strengths to reduce threats
	S2T1 Political factors threaten teaching and learning to enhance digital literacy concerning: S2T111 *digital social responsibility* (1.330) S2T112 *digital communication and collaboration* (.89)
	S2T2 Economic factors threaten teaching and learning to enhance digital literacy, concerning: S2T231 *digital and computational thinking* (.814) S2T232 *digital communication and collaboration* (.526)
	S2T3 Social and cultural factors threaten teaching and learning to enhance digital literacy, concerning: S2T341 *digital knowledge and skills* (.700) S2T342 *digital awareness* (.617)
	S2T4 Technological factors threaten teaching and learning to enhance digital literacy concerning: S2T431 *digital awareness* (.515) S2T432 *digital knowledge and skills* (.484) S2T433 *digital communication and collaboration* (.456) S2T434 *digital social responsibility* (.303)

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Academic Management of Public Universities to Enhance the Digital Literacy	TOWS Matrix
	Weakness-Opportunity (WO): Reduce weaknesses to develop opportunities
	W3O2 Social and Cultural factors enable teaching and learning to enhance digital literacy concerning: W32 *digital social responsibility* (.578)
	W3O3 Economic factors enable teaching and learning to enhance digital literacy concerning: W31 *digital awareness* (.621) W32 *digital social responsibility* (.578)
	Weaknesses-Threat (WT): Avoid threats by reducing weaknesses
	W3T1 Political factors threaten teaching and learning to enhance digital literacy concerning: W32 *digital social responsibility* (.578)
	W3T3 Social and cultural factors threaten teaching and learning to enhance digital literacy, concerning: W31 *digital awareness* (.621)
	W3T4 Technological factors threaten teaching and learning to enhance digital literacy concerning: W31 *digital awareness* (.621) W32 *digital social responsibility* (.578)

Table 7.
TOWS Matrix (Curriculum Development-External Factors).

Academic Management of Public Universities to Enhance the Digital Literacy	TOWS Matrix
Curriculum Development (.569)	Strength-Opportunity (SO): Use strengths to maximize opportunities
	S3O1 Technological factors enable curriculum development to enhance digital literacy concerning: O131 *digital social responsibility* (.321) O132 *digital and computational thinking* (.355)
	S3O2 Social and Cultural factors enable curriculum development to enhance digital literacy concerning: O231 *digital communication and collaboration* (.367) O232 *digital social responsibility* (.455)
	S3O3 Economic factors enable curriculum development to enhance digital literacy concerning: O341 *digital and computational thinking* (.414) O342 *digital social responsibility* (.503) O343 d*igital knowledge and skills* (.704)
	S3O4 Political factors enable curriculum development to enhance digital literacy concerning: O411 *digital and computational thinking* (.272) O412 *digital awareness* (.341) O413 *digital communication and collaboration* (.357) O414 *digital social responsibility* (.396)
	Strength-Threats (ST): Use strengths to reduce threats
	S3T1 Political factors threaten curriculum development to enhance digital literacy concerning: T141 d*igital knowledge and skills* (.964)
	S3T2 Economic factors threaten curriculum development to enhance digital literacy, concerning: T211 d*igital communication and collaboration* (1.2) T212 Economic factors threaten curriculum development to enhance digital literacy concerning d*igital awareness* (.969)
	S3T3 Social and cultural factors threaten curriculum development to enhance digital literacy, concerning:

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Academic Management of Public Universities to Enhance the Digital Literacy	TOWS Matrix
	T321 *digital and computational thinking* (.622) T322 *digital awareness* (.565) T323 *digital knowledge and skills* (.495)
	S3T4 Technological factors threaten curriculum development to enhance digital literacy concerning: T421 *digital communication and collaboration* (.789) T422 *digital knowledge and skills* (.607) T423 *digital awareness* (.572)
	Weakness-Opportunity (WO): Reduce weaknesses to develop opportunities
	W2O1 Technological factors enable curriculum development to enhance digital literacy concerning: W21 Curriculum Development in enhancing *digital and computational thinking (.790)* W22 Curriculum Development in enhancing *digital social responsibility (.636)*
	W2O2 Social and Cultural factors enable curriculum development to enhance digital literacy concerning: W22 Curriculum Development in enhancing *digital social responsibility (.636)*
	W2O3 Economic factors enable curriculum development to enhance digital literacy concerning: W21 Curriculum Development in enhancing *digital and computational thinking (.790)* W22 Curriculum Development in enhancing *digital social responsibility (.636)*
	W2O4 Political factors enable curriculum development to enhance digital literacy concerning: W21 Curriculum Development in enhancing *digital and computational thinking (.790)* W22 Curriculum Development in enhancing *digital social responsibility (.636)*
	Weaknesses-Threat (WT): Avoid threats by reducing weaknesses
	W2T3 Social and cultural factors threaten curriculum development to enhance digital literacy concerning: W21 Curriculum Development in enhancing *digital and computational thinking (.790)*

Table 8.
TOWS Matrix (Learning Media and Resources-External Factors).

Academic Management of Public Universities to Enhance the Digital Literacy	TOWS Matrix
Learning Media and Resources (.775) W11 Learning Media and Resources in enhancing *digital awareness (1.065)* W12 Learning Media and Resources in enhancing *digital communication and collaboration (.969)* W13 Learning Media and Resources in enhancing *digital social responsibility (.705)* W14 Learning Media and Resources in enhancing *digital knowledge and skills (.577)*	**Strength-Opportunity (SO): Use strengths to maximize opportunities**
	S4O1 Technological factors enable Learning Media and Resources to enhance digital literacy concerning: O141 *digital and computational thinking* (.353)
	S4O2 Social and Cultural factors enable Learning Media and Resources to enhance digital literacy concerning:

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Academic Management of Public Universities to Enhance the Digital Literacy	TOWS Matrix
	O241 *digital communication and collaboration* (.375) O242 d*igital and computational thinking* (.510) O243 *digital social responsibility* (.513)
	S4O3 Economic factors enable Learning Media and Resources to enhance digital literacy concerning: O311 *digital knowledge and skills* (.099)
	Strength-Threats (ST): Use strengths to reduce threats
	S4T1 Political factors threaten Learning Media and Resources to enhance digital literacy concerning: T121 *digital and computational thinking* (.665) T122 d*igital social responsibility* (.636) T123 *digital knowledge and skills* (.618) T124 d*igital awareness* (.541) T125 *digital communication and collaboration* (.360)
	S4T2 Economic factors threaten Learning Media and Resources to enhance digital literacy concerning: T241 *digital social responsibility* (.523) T242 *digital communication and collaboration* (.470) T243 *digital awareness* (.431) T244 *digital and computational thinking* (.379)
	S4T3 Social and cultural factors threaten Learning Media and Resources to enhance digital literacy concerning: T311 *digital awareness* (.977) T312 d*igital knowledge and skills* (.796)
	S4T4 Technological factors threaten Learning Media and Resources to enhance digital literacy concerning: T411 *digital communication and collaboration* (.777) T412 *digital social responsibility* (.746) T413 *digital knowledge and skills* (.684) T414 *Digital awareness* (.679)
	Weakness-Opportunity (WO): Reduce weaknesses to develop opportunities
	W1O2 Social and Cultural factors enable Learning Media and Resources to enhance digital literacy concerning: W12 Learning Media and Resources in enhancing *digital communication and collaboration (.969)* W13 Learning Media and Resources in enhancing *digital social responsibility (.705)*
	W1O3 Economic factors enable Learning Media and Resources to enhance digital literacy concerning: W14 Learning Media and Resources in enhancing *digital knowledge and skills (.577)*
	Weaknesses-Threat (WT): Avoid threats by reducing weaknesses
	W1T1 Political factors threaten Learning Media and Resources to enhance digital literacy concerning: W11 Learning Media and Resources in enhancing *digital awareness (1.065)* W12 Learning Media and Resources in enhancing *digital communication and collaboration (.969)* W13 Learning Media and Resources in enhancing *digital social responsibility (.705)* W14 Learning Media and Resources in enhancing *digital knowledge and skills (.577)*
	W1T2 Economic factors threaten Learning Media and

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Academic Management of Public Universities to Enhance the Digital Literacy	TOWS Matrix
	Resources to enhance digital literacy concerning: W11 Learning Media and Resources in enhancing *digital awareness (1.065)* W12 Learning Media and Resources in enhancing *digital communication and collaboration (.969)* W13 Learning Media and Resources in enhancing *digital social responsibility (.705)*
	W1T3 media and resources to enhance digital literacy concerning: W11 Learning Media and Resources in enhancing *digital awareness (1.065)* W14 Learning Media and Resources in enhancing *digital knowledge and skills (.577)*
	W1T4 Technological factors threaten Learning Media and Resources to enhance digital literacy concerning: W11 Learning Media and Resources in enhancing *digital awareness (1.065)* W12 Learning Media and Resources in enhancing *digital communication and collaboration (.969)* W13 Learning Media and Resources in enhancing *digital social responsibility (.705)* W14 Learning Media and Resources in enhancing *digital knowledge and skills (.577)*

Table 9.
TOWS Matrix Conclusion.

Academic Management of Public Universities to Enhance the Digital Literacy	Political (P)	Economic (E)	Sociocultural (S)	Technological (T)
1. Curriculum Development	SO	ST	ST	ST
1.1 Digital awareness	SO	ST	ST	ST
1.2 Digital communication and collaboration	SO	ST	SO	ST
1.3 Digital and Computational Thinking	WO	WO	WT	WO
1.5 Digital knowledge and skills	ST	SO	ST	ST
1.6 Digital social responsibility	WO	WO	WO	WO
2. Teaching and learning	ST	SO	SO	SO
2.1 Digital awareness	WO	WO	WT	WT
2.2 Digital communication and collaboration	ST	ST	SO	ST
2.3 Digital and Computational Thinking	SO	ST	SO	SO
2.5 Digital knowledge and skills	SO	SO	ST	ST
2.6 Digital social responsibility	WT	WO	WO	WT
3. Learning Media and Resources	WO	WT	WT	WT
3.1 Digital awareness	WT	WT	WT	WT
3.2 Digital communication and collaboration	WT	WT	WO	WT
3.3 Digital and Computational Thinking	ST	SO	SO	SO
3.5 Digital knowledge and skills	WT	WO	WT	WT
3.6 Digital social responsibility	WT	WO	WO	WT
4. Measurement and Evaluation	SO	SO	SO	SO
4.1 Digital awareness	SO	SO	SO	SO
4.2 Digital communication and collaboration	ST	ST	SO	SO
4.3 Digital and Computational Thinking	ST	ST	SO	SO
4.5 Digital knowledge and skills	ST	SO	ST	SO
4.6 Digital social responsibility	WO	WO	WT	WT

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Table 10.
Strategy Development Based on the Quantitative Findings and Analysis.

Strategies	Sub Strategies	Procedures
1. Redesign Curriculum to enhance digital literacy (SO)	1.1 Integrate digital literacy as an expected outcome into the existing curriculum system, specifically on Digital awareness, Digital communication, and collaboration. (SO) Curriculum Development in enhancing *digital communication and collaboration (.411)* Curriculum Development in enhancing *digital awareness (.419)* Curriculum Development in enhancing *digital knowledge and skills (.462)*	1. (Curriculum design) Mandate the inclusion of specific, measurable digital literacy learning outcomes in all new and revised course syllabi. 2. (Teaching content) Create and require a first-year foundational course ("Digital Citizenship & Collaboration") with standardized teaching content on ethics and tools. 3. (Teaching method) Implement a curriculum mapping exercise to identify and strengthen how digital communication is taught and assessed across all programs.
	1.2 Embed scaffolded digital competencies into major-specific pathways, focusing on advanced digital tools and computational thinking relevant to the field. Curriculum Development in enhancing *digital communication and collaboration (.411)* Curriculum Development in enhancing *digital awareness (.419)* Curriculum Development in enhancing *digital knowledge and skills (.462)*	1. (Curriculum design) Design a scaffolded curriculum where digital tool complexity increases from introductory to capstone courses. 2. (Teaching content) Develop "digital methods" minors or certificates to provide deeper, credentialed teaching content in specialized areas. 3. (Teaching method) Incorporate "Digital Portfolio" development as a graduation requirement, using a reflective teaching method to demonstrate competency growth.
2. Strengthen the Teaching and learning to enhance digital literacy (SO)	2.1 Implement comprehensive and mandatory professional development for faculty on digital pedagogy and tools. Teaching and learning in enhancing *digital communication and collaboration (.455)* Teaching and learning in enhancing *digital and computational thinking (.483)* Teaching and learning in enhancing *digital knowledge and skills (.497)*	1. (Teachers' teaching ability) Establish a "Digital Teaching Fellows" program to train faculty champions in digital pedagogy who can then coach their peers. 2. (Using digital teaching methods) Offer recurring, hands-on workshops on using the LMS, integrating new technologies (VR, AI), and designing collaborative online assignments. 3. (Teachers' teaching ability) Create a grant fund to incentivize and support faculty to innovate and redesign their courses with significant digital literacy components.
	2.2 Promote active and collaborative learning models that necessitate the use of digital tools. Teaching and learning in enhancing *digital communication and collaboration (.455)* Teaching and learning in enhancing *digital and computational thinking (.483)* Teaching and learning in enhancing *digital knowledge and skills (.497)*	1. (Teaching method) Train faculty in the "Flipped Classroom" model, using digital media for content delivery and reserving class time for collaborative, tool-based problem-solving. 2. (Teaching method) Encourage project-based learning (PBL) where student groups must use digital tools for research, creation, and presentation. 3. (Creating a digital environment) Incorporate digital simulations and gamified learning platforms to create an immersive and interactive digital learning environment.
3. Developing Learning Media and Resources to enhance digital literacy (WO)	3.1 Develop technology-based learning media and resources to enhance digital literacy, specifically on *digital and computational thinking* (.353) Learning Material and Resources in	1. (Teaching content) Develop a repository of interactive, modular teaching content (simulations, coding exercises) focused on computational logic and data analysis. 2. (Teachers' teaching ability) Create video micro-

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Strategies	Sub Strategies	Procedures
	enhancing *digital awareness (1.065)* Learning Materials and Resources in enhancing *digital communication and collaboration (.969)* Learning Material and Resources in enhancing *digital social responsibility (.705)* Learning Materials and Resources in enhancing *digital knowledge and skills (.577)*	courses to upskill faculty and students on fundamental digital tools and computational concepts. 3. (The digital learning equipment) Partner with departments to create and provide access to discipline-specific digital software and toolkits.
	3.2 Apply social and community resources to enhance digital literacy, specifically on *digital communication and collaboration* (.375), d*igital and computational thinking* (.510), *digital social responsibility* (.513) Learning Material and Resources in enhancing *digital awareness (1.065)* Learning Materials and Resources in enhancing *digital communication and collaboration (.969)* Learning Material and Resources in enhancing *digital social responsibility (.705)* Learning Materials and Resources in enhancing *digital knowledge and skills (.577)*	1. (Creating a digital environment) Launch a "Digital Citizen Ambassador" program that extends the learning environment into local community centers and libraries. 2. (Cultivating students' digital literacy) Organize hackathons with local non-profits to cultivate digital social responsibility and collaborative problem-solving skills. 3. (Using digital teaching methods) Establish a digital mentorship program that uses collaboration platforms (Slack, Zoom) to connect students with professionals.
	3.3 The university leadership can partner with local chambers of commerce and economic development boards to develop Learning Media and Resources focusing on the cultivation of *digital knowledge and skills* (.099) Learning Material and Resources in enhancing *digital awareness (1.065)* Learning Materials and Resources in enhancing *digital communication and collaboration (.969)* Learning Material and Resources in enhancing *digital social responsibility (.705)* Learning Materials and Resources in enhancing *digital knowledge and skills (.577)*	1. Co-create a "Digital Skills for the Local Economy" webinar series featuring industry leaders discussing in-demand skills like CRM software, digital marketing analytics, and e-commerce platforms. 2. Develop case studies and learning modules based on real-world challenges provided by local businesses, allowing students to apply digital tools to propose solutions. 3. Establish a joint internship portal with the Chamber of Commerce that promotes opportunities specifically focused on developing and applying digital literacy skills in a business context.
4. Transform Measurement and Evaluation to enhance digital literacy (SO)	4.1 Develop a standardized digital literacy competency assessment to be administered at entry and exit. Measurement and evaluation in enhancing *digital communication and collaboration (.306)* Measurement and evaluation in enhancing *digital communication and collaboration (.338)* Measurement and evaluation in enhancing *digital awareness (.348)* Measurement and evaluation in enhancing *digital knowledge and skills (.487)*	1. (Using various methods) Adopt a validated digital literacy assessment to measure competencies at entry and exit, providing a clear method for tracking growth. 2. (Providing holistic and comprehensive information) Analyze the assessment data programmatically and by demographic to provide comprehensive information on program effectiveness and equity gaps. 3. (Supporting student progress) Use the baseline data to provide targeted support and resources to students who enter with lower levels of digital literacy.
	4.2 Shift evaluation methods from traditional exams to authentic assessments that demonstrate digital skills. Measurement and evaluation in enhancing *digital communication and collaboration (.306)*	1. (Using various methods) Replace standard exams with authentic assessments requiring the creation of digital artifacts (podcasts, websites, visualizations). 2. (Providing holistic and comprehensive

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Strategies	Sub Strategies	Procedures
	Measurement and evaluation in enhancing *digital communication and collaboration (.338)* Measurement and evaluation in enhancing *digital awareness (.348)* Measurement and evaluation in enhancing *digital knowledge and skills (.487)*	information) Design evaluations that mimic real-world tasks (managing a shared project plan, contributing to a wiki) to provide a more holistic view of student capability. 3. (Supporting student progress) Utilize peer-assessment tools within the LMS to give students comprehensive feedback on their collaborative contributions and digital work.
	4.3 Integrate digital badge or micro-credentialing systems to recognize and certify digital competencies, specifically focusing on digital social responsibility. Measurement and evaluation in enhancing *digital communication and collaboration (.306)* Measurement and evaluation in enhancing *digital communication and collaboration (.338)* Measurement and evaluation in enhancing *digital awareness (.348)* Measurement and evaluation in enhancing *digital knowledge and skills (.487)*	1. Using various methods, partner with a badging platform to issue digital badges for mastery of specific skills in privacy and ethics, healthy digital behavior, and cultural and ethical awareness, providing a new method of credentialing. 2. Providing accurate and comprehensive digital information. Ensure each badge provides accurate, verifiable metadata describing the specific digital social responsibility skill and ethical criteria for earning it. 3. (Supporting student progress) Promote these verified micro-credentials to employers via career services, supporting student career progression with comprehensive evidence of their ethical digital social responsibility skills.

4.3. Evaluation, Justification and Finalization of the Academic Management Strategy

Expert evaluation concerning the practicality, feasibility, and validity while implementing revealed a strong consensus on digital literacy strategies for these public universities, with high mean scores and low standard deviations indicating unanimous approval. Three strategies achieved a perfect mean score (5.00) with zero deviation: embedding digital competencies into major-specific pathways, developing technology-based learning media, and applying social and community resources. These were identified as foundational priorities with clear implementation pathways.

Slightly lower scores (mean 4.60) for strategies such as integrating digital literacy as a broad expected outcome and implementing digital badge systems suggest perceived implementation challenges, possibly related to institutional bureaucracy and technical requirements. Despite high overall support, these strategies require more detailed planning.

The results provide a strategic implementation sequence: beginning with the perfect-score strategies, followed by high-scoring initiatives (4.80), and finally addressing those with slightly lower scores through careful planning and pilot programs. This layered approach transforms the evaluation into a practical roadmap for action.

The proposed strategies for enhancing digital literacy have been refined to improve implementability through collaborative, phased, and resource-conscious approaches (see **Figure**). Rather than applying broad mandates, the modified procedures emphasize building faculty buy-in and testing concepts on a smaller scale before institution-wide rollout. For instance, defining digital literacy outcomes is now a collaborative task force effort, and new requirements are first piloted in volunteer departments. This shift reduces resistance and allows practical refinement. In the final phase, a focus group discussion involving academic leaders and faculty representatives was conducted to critically review these refined strategies, ensuring their contextual relevance, feasibility, and alignment with institutional priorities.

Support structures are prioritized to facilitate adoption for faculty. Professional development leverages peer coaching and recorded workshops, while active learning initiatives are supported with curated resources and dedicated staff assistance. The development of new learning media focuses on leveraging existing platforms and faculty-led committees to ensure relevance and usability.

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Partnerships with community and industry are designed to be sustainable by building on existing networks like alumni relations and chambers of commerce, starting with low-commitment, high-value activities such as webinar series and promoted internships.

Assessment strategies emphasize ethical piloting and supportive implementation. Standardized assessments are first piloted with cohorts, and authentic assessment transitions are supported with instructional design resources. Digital badge programs begin with targeted high-demand skills rather than full-scale implementation, ensuring credibility and employer recognition before wider adoption.

These modifications collectively shift the approach from a top-down requirement to supported integration, increasing practicality and potential for long-term success. The detailed and finalized academic management strategy for the enhancement of digital literacy is as follows:

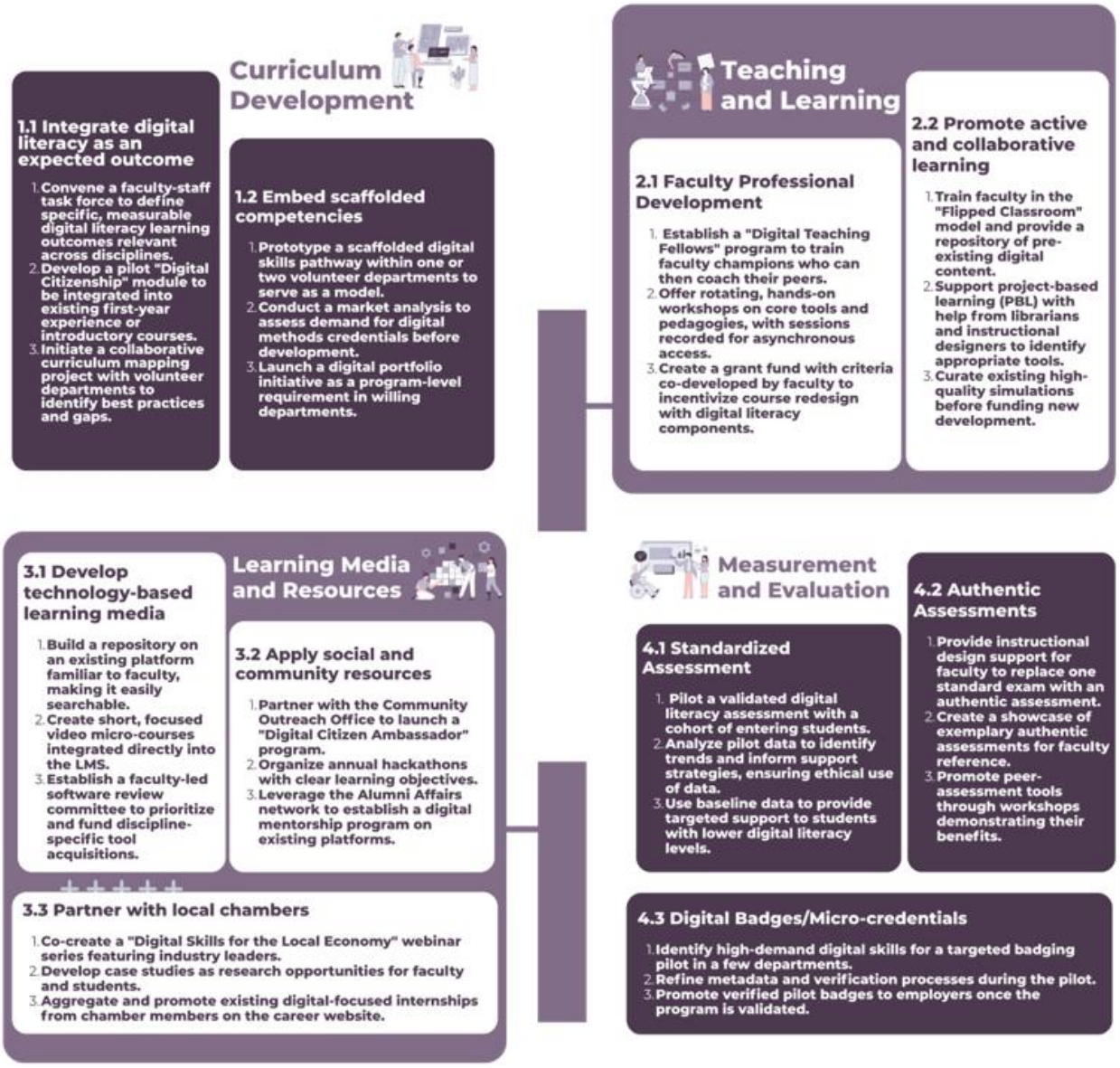

Figure 1.
Academic Management to Enhance Digital Literacy.

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5. Discussion

This research transformed the empirical insights gained from the earlier phases into a comprehensive strategic framework for enhancing digital literacy through academic management in public universities across one selected province. Guided by the validated conceptual framework and the detailed SWOT analysis, the strategy development process moved beyond simple recommendations and became a structured exercise in institutional planning. Draft strategies were first generated through a TOWS analysis that linked internal strengths and weaknesses with external opportunities and threats, then subjected to iterative expert review and focus-group validation. The resulting framework represented a carefully modified final version that responded directly to the needs and realities revealed in Phases I and II.

The strategies integrated all four components of academic management curriculum development, teaching and learning, learning media and resources, and measurement and evaluation because the earlier findings had shown that weaknesses in any single component limited overall progress. For curriculum development, the framework emphasized embedding digital literacy as an expected outcome in every program of study. Rather than relegating technology skills to optional modules, digital citizenship and scaffolded skills pathways were to be woven through disciplinary curricula, supported by collaborative curriculum mapping and pilot projects. This direction directly addressed the substantial $PNI_{modified}$ gap identified in Phase II and resonated with the conclusions of Voogt and Roblin, and Kim, who argue that genuine digital competence emerges only when digital outcomes are integrated across the curriculum rather than taught as isolated technical skills [39, 40].

Teaching and learning formed the second strategic pillar. The final plan called for a sustained program of professional development to cultivate faculty as change agents. Initiatives such as a "Digital Teaching Fellows" scheme, hands-on workshops, and incentives for course redesign were designed to harness the enthusiasm of younger, technologically adept faculty while supporting colleagues less confident with new pedagogies. This peer-mentoring approach echoes the previous findings that faculty-led professional learning communities are among the most effective mechanisms for embedding digital pedagogy and sustaining innovation over time [41].

The third element of the strategy focused on learning media and resources. National analyses continue to highlight significant urban–rural gaps in China's digital infrastructure, which hinder equitable access to high-quality learning opportunities [20]. To narrow these disparities, the framework proposed creating a central repository of digital course materials on platforms familiar to faculty, developing short micro-courses within the learning management system, and fostering partnerships with alumni, community organizations, and local industry. Such collaborations echo international recommendations that universities embed real-world industry practice into virtual learning to strengthen students' digital competencies and professional readiness [21].

Finally, the strategy addressed a critical deficit in measurement and evaluation uncovered during Phase II: without reliable assessment mechanisms, curriculum reforms and teaching innovations risk stagnation. To remedy this, the plan proposed piloting standardized digital-literacy assessments for incoming students, promoting authentic assessment practices in place of traditional exams, and introducing digital badges and micro-credentials to recognize specific skill achievements. These proposals resonate with global trends. For example, the EPICA project demonstrates how competency-based ePortfolios and badges can enhance employability skills across higher education settings [35]. Further, reviews of micro-credentials emphasize that when assessment is authentic, transparent, and linked to real-world competencies, graduates benefit both in skill recognition and employability [25, 42, 43].

The development of this strategic framework demonstrated the importance of aligning internal capabilities with external policy drivers. By leveraging China's national agenda for digital transformation as laid out in the *14th Five-Year Plan* and the national plan to boost digital literacy and skills, the strategy secured strong governmental support while also confronting local weaknesses such

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as infrastructure disparities and inconsistent faculty development. This approach reflects the strengths of participatory, evidence-based strategic planning as advocated by Bryson and Edwards [44], who emphasize that public sector planning works best when internal capacities are matched to external mandates and when reforms are grounded in rigorous evaluation [44].

Overall, the Phase III findings showed that enhancing digital literacy in Henan's public universities required more than the introduction of new technologies. It demanded a systemic and interdependent set of actions: curriculum integration to ensure that every student encounters digital competencies throughout their program of study; professional learning structures that empower faculty to lead innovation; resource development and community partnerships that expand access and authenticity; and rigorous, forward-looking assessment systems that both document and drive progress. By situating these strategies within the national policy context and grounding them in empirical evidence, the research produced a framework that is both theoretically robust and practically feasible. Moreover, because the strategy responds to challenges common to many higher-education systems curricular fragmentation, uneven resources, and the need for credible evidence of student digital competence, it offers a model that can be adapted by universities beyond Henan and even beyond China.

Institutional Review Board Statement:

This study was conducted in accordance with the ethical standards for educational research and the Declaration of Helsinki. The research proposal was reviewed and approved by the Faculty of Education, Chulalongkorn University, Thailand, as part of the doctoral research requirements (protocol code 053/2566-201/2567). The study did not involve any medical or biological experimentation and ensured voluntary participation, anonymity, and confidentiality of all participants. Prior to data collection, informed consent was obtained from all respondents, who were informed of the purpose, scope, and voluntary nature of their participation. No personal identifiers were collected, and data were used solely for academic research purposes.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

Copyright:

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