International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 25s,2025
https://theaspd.com/index.php

AI Knowledge Diffusion And Student Innovation In Higher Education Institutions In Oman: Conceptual Framework

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Abstract: *Higher education institutions see Artificial Intelligence (AI) as a game-changing element because it holds the potential to increase student innovation. Oman's Vision 2040 strategic agenda support digital transformation but shows inconsistent AI knowledge distribution within its academic entities. This study investigates the connection between AI knowledge dissemination and student innovation development within Omani academic institutions. The new conceptual framework combines technology adoption models, TOE and UTAUT, with constructivist learning principles while recognising institutional readiness as a crucial contextual enabler and educational culture as a socio-cultural moderator. Research based on case studies, combined with stakeholder feedback and grey literature, uncovers essential deficiencies in faculty development programs, curriculum implementation, and organisational policies. The framework supplies actionable methods to incorporate AI into teaching approaches and organizational planning. The research presents essential guidance for policymakers and academic leaders who want to develop educational ecosystems that support innovation through AI technology.*
Keywords: *AI Knowledge Diffusion, Higher Education, Student Innovation.*

1. INTRODUCTION

AI knowledge diffusion has become a crucial strategic component to revolutionize educational ecosystems specifically at higher education institutions (HEIs). In 2024 Jo described AI knowledge diffusion as the conversion of shared knowledge into usable insights which drive behavioural changes and practical implementations in educational environments. Cano and Nunez (2024) describe AI diffusion through their concept of a socially constructed and technology-mediated engagement process which has a direct impact on student innovation and creativity. Çelebi and Pinar (2024) describe smart learning as dependent upon user engagement together with contextual applicability and learner control over their educational experience.

This research presents AI knowledge diffusion as a process that methodically distributes AI capabilities throughout educational institutions to foster student-driven innovation through technological involvement supported by real-world applications and socio-cultural frameworks (Ayanwale et al., 2025; Molefi et al., 2024).

At a higher education institution in Oman AI tools like MATLAB, ChatGPT and engineering simulations have been adopted but remain restricted to standalone activities without meaningful incorporation into the curriculum. Instruction design for AI-based assignments faces faculty resistance because educational models for AI are insufficient alongside institutional incentives and academic honesty issues (Kavitha and Joshith, 2025; Montenegro, 2024). Students acknowledge the innovative nature of AI but frequently experience only superficial interaction which stops at demonstration-based activities.

Supporting these observations, Zada et al. Zada and colleagues (2024) maintain that ethical, social and governance elements are crucial for AI implementation to succeed. Petz (2022) identifies system-level design thinking as critical when embedding innovation frameworks into educational curriculum structures. Oman finds the process of both learning AI principles and disseminating them more complicated because their educational standards prioritize test performance instead of hands-on experimentation (Prieto and Talukder, 2023).

Stakeholder consultations—including surveys and interviews with educators, curriculum officers, and senior students—revealed common challenges: Barriers appear because faculty training is missing while educational programs remain rigid and cross-disciplinary opportunities are limited (Raman et al., 2024). Strategic internal documents and Oman Vision 2040 grey literature validate the presence of this problem. AI has been

established as a national enabler, but institutions remain inadequately prepared (Zulu et al., 2023; Mutia et al., 2024).

Triangulation of these insights reveals a clear contextual pattern: Institutional readiness remains the primary determinant of AI diffusion since it requires the alignment of resources with leadership and structural and cultural components. Institutional readiness requires not only infrastructure but also educational policies together with faculty development systems and student access initiatives (Lee and Kim, 2023).

AI access represents only one part of the current challenge which is further complicated by institutional abilities to distribute knowledge. The critical challenge affects both educators and students in addition to leaders from multiple sectors because Oman is working to synchronize its educational approaches with Vision 2040 objectives. The study establishes an AI innovation framework for Higher Education Institutions which combines local specificity with general applicability by analysing institutional readiness to serve as a contextual catalyst (Geng et al., 2023; Camilleri and Camilleri, 2022).

2. Contextual Grounding & Problem Exploration

The field of Artificial Intelligence (AI) functions as a transformative element in education because it improves learning results and fosters interdisciplinary teamwork while developing essential future skills. Higher education institutions (HEIs) demonstrate variable and theoretically shallow diffusion patterns of AI knowledge which involves systematic circulation and pedagogical use of AI tools and mindsets (Jo, 2024; Ayanwale et al., 2025; Wolbring and Gill, 2023). Although global and regional educational policies recommend AI integration strategies, institutions undergoing digital change face the lack of effective frameworks to establish enduring AI knowledge diffusion as noted by Zamani and Rousaki (2024) and Mutia et al. (2024).

Despite Vision 2040 governmental commitments to establish a digitally empowered knowledge society in Oman higher education institutions struggle to implement these objectives. Higher education institutions experience insufficient faculty development programs while dealing with uncoordinated infrastructure and fixed curriculum frameworks (Zulu et al., 2023; Montenegro, 2024). ChatGPT and AI-based lab simulations have been introduced but their incorporation into teaching practices continues to occur on an unstructured basis. Institutional capacity has not kept pace with technological availability which has resulted in a disparity between potential outcomes and actual practice according to Lee and Kim (2023).

3. Problem Statement

Omani HEIs now have better access to AI technologies but still lack insight into the effective distribution of AI knowledge that promotes student innovation. Lack of established institutional strategies alongside insufficient pedagogical adoption models and cultural readiness limits AI's transformative potential.

4. Purpose Statement

The study focuses on creating a contextualized conceptual framework to reveal how AI knowledge diffusion enables student innovation within Omani higher education institutions.

5. Research Questions

1. Which theoretical and contextual factors drive AI knowledge diffusion in higher education institutions in Oman?
2.

6. Literature Foundations

Research by scholars in educational AI shows significant advancements in recognizing how this technology can transform teaching through automated evaluation and personalized learning systems. Current research models in AI education fail to integrate structural elements with teaching approaches and cultural influences that enable AI knowledge dissemination while only focusing separately on technological access or user behavior (Jo, 2024; Wolbring and Gill, 2023).

A. Technological Capability (TOE Framework)

The definition of technological capability includes the combination of institutional infrastructure with platform availability and digital maturity. According to Alsoud et al. Research by Alsoud et al. shows that technological potential needs strategic alignment with learner preferences and institutional goals to generate meaningful impact. (2024). The TOE theory recognizes technological capability as a necessary element for innovation adoption. Institutional innovation readiness assessments have relied heavily on this theory according to Zulu et al. (2023) and Camilleri and Camilleri (2022).

B. Pedagogical Adoption (UTAUT)

The Unified Theory of Acceptance and Use of Technology (UTAUT) demonstrates how perceived usefulness; effort expectancy and institutional support affect behavioral intention. Faculty members adopt AI technology based on their technological familiarity and institutional promotion along with peer support as Kavitha and Joshith (2025) and Pernaa et al. demonstrate. (2024). Traditional teaching methods that focus on content in Oman create barriers to adopting technological instructional innovations.

C. Student Engagement (Constructivist Learning Theory)

Educators have traditionally identified student engagement as an indicator of potential for innovation. Students achieve optimal learning results when they create knowledge through direct engagement with real-world contexts according to constructivist theory. Research by Cano and Nunez (2024) together with Çelebi and Pinar (2024) demonstrates how emotional involvement and personal relevance become crucial factors in AI-mediated learning environments. Wu et al. The study by Wu et al. (2022) demonstrates that cognitive load together with motivation and technology engagement serve as predictors of learning achievement in STEAM education.

D. Contextual Variable – Institutional Readiness

The measure of institutional readiness includes elements such as organizational leadership along with policy environment and training systems and organizational culture. The research by Zamani and Rousaki (2024) demonstrates that digital transformation requires more than platform acquisition and needs to focus on systemic alignment. Geng et al. (2023) and Field et al. Field et al. (2021) maintain that digital innovation requires integration into organizational governance frameworks as well as professional development programs and strategic plans.

E. Synthesis of Existing Theories

Although HEIs increasingly acknowledge AI's importance higher education institutions still operate under incomplete models. Research efforts utilizing UTAUT frequently overlook the impact of structural barriers and cultural dynamics (Al-Adwan et al., 2023). Constructivist analyses examine classroom-level phenomena but fail to address drivers that span entire institutions. Research lacks a comprehensive framework to combine AI adoption with student behavior and organizational structures within Middle Eastern academic settings (Yong et al., 2025).

F. Identification of Gaps

Jo's 2024 research identifies a clear separation between behavioral methods and structural strategies. Zulu et al. Zulu et al. (2023) identified an important deficit in theoretical research regarding institutional readiness and government structures. Research on socio-cultural drivers behind AI knowledge sharing shows limited analysis according to Mutia and colleagues (2024). Cano and Nunez (2024) identify a critical absence of complete frameworks that unite engagement aspects and teaching methods with technology systems to support ongoing innovation.

The framework corrects existing gaps through the integration of TOE and UTAUT with constructivist learning theory while assessing institutional readiness based on local contexts. The framework maintains its theoretical foundation while it adjusts its methods to match Oman's cultural context and meets both student requirements and policy standards. The model enables institutions to understand AI diffusion as an ongoing transformative process that needs simultaneous involvement and adjustment rather than step-by-step tool implementation.

G. Conceptual Framework Development

The conceptual framework presented here examines the theoretical elements and logical structure of AI knowledge diffusion's influence on student innovation within Omani Higher Education Institutions. Three theoretical constructs focusing on technological capability pedagogical adoption and student engagement

make up the framework which integrates an institutional readiness construct as well as a socio-cultural educational culture moderating variable (See figure 1).

7. Variable Definitions

A. Technological Capability

Technological capability consists of institutional infrastructure and digital tools which create technological ecosystems that enable AI learning implementation according to research by Alsoud et al. (2024) and Camilleri & Camilleri (2022). The Omani environment demonstrates technological capability through independent examples such as MATLAB and AI simulators but does not show unified strategic integration. The TOE model identifies infrastructure as a crucial element that enables technological capability within its innovation adoption framework (Zulu et al., 2023).

B. Pedagogical Adoption

The pedagogical adoption concept reveals faculty readiness to integrate AI technologies into their teaching methods. The Unified Theory of Acceptance and Use of Technology (UTAUT) forms the essential framework for this construct which shows that faculty attitudes along with institutional support structures and expectations drive behavioral intentions towards AI adoption (Pernaa et al., 2024; Kavitha & Joshith, 2025). The researchers selected this construct instead of "user satisfaction" because it has more robust theoretical underpinnings and demonstrates better suitability for lasting institutional change.

C. Student Engagement

Student engagement involves learners' cognitive processes and emotional responses as well as their active participation in artificial intelligence-driven educational settings. According to Constructivist Learning Theory students achieve optimal learning through interactive activities and inquiry-based tasks which allow them to apply contextual knowledge and understanding (Cano & Nunez, 2024; Çelebi & Pinar, 2024; Wu et al., 2022). The selection of this measurement instead of GPA or digital attendance resulted from its better fit with the principles of student innovation.

D. Institutional Readiness (Contextual Variable)

Qualitative insights from stakeholders and grey literature analysis revealed institutional readiness as a primary factor for AI knowledge diffusion. The components of institutional readiness encompass leadership support along with digital governance structures as well as curriculum flexibility and professional development systems (Zamani & Rousaki, 2024; Field et al., 2021). Oman's higher education institutions own AI tools yet lack the necessary systemic processes to use them effectively (Lee & Kim, 2023).

8. Inter-Variable Relationships

A. 1 → 2: Technological Capability → Pedagogical Adoption

Faculty members can experiment with and integrate AI tools when robust digital ecosystems are available. Without these technologies pedagogical advancements stay theoretical and fail to connect with actual teaching methods (Jo, 2024; Alsoud et al., 2024).

B. 1 → 3: Technological Capability → Student Engagement

When students use easy-to-operate AI platforms like simulation tools and chatbots their learning independence increases along with cognitive engagement which strengthens constructivist educational settings (Çelebi & Pinar, 2024; Molefi et al., 2024).

C. 1 → 4: Technological Capability → Institutional Readiness

Digital infrastructure investments indicate institutional vision and priorities despite technology not being sufficient to ensure readiness, according to Camilleri & Camilleri (2022) and Zulu et al. (2023).

D. 2 → 3: Pedagogical Adoption → Student Engagement

Teachers who intentionally integrate AI into their teaching methods create an environment that encourages students to explore more deeply. Students who apply AI toward real-world issues show increased intrinsic motivation according to research findings (Pernaa et al., 2024; Montenegro, 2024).

E. 2 → 4: Pedagogical Adoption → Institutional Readiness

When educators broadly adopt new practices they cause significant changes in assessment methods, resource distribution, and teacher training programs (Geng et al., 2023).

F. 3 → 4: Student Engagement → Institutional Readiness

Institutions scale resources, adjust programs and establish formal AI-supported pathways once they observe student enthusiasm and success in AI-driven tasks (Cano & Nunez, 2024).

9. Moderating Variable: Educational Culture

Educational culture represents collective beliefs and traditional attitudes in academic institutions which determine their willingness to embrace change. Educational culture operates as the moderating variable for the model because conservative academic environments might resist AI adoption even when tools and policies are in place (Prieto & Talukder, 2023; Mutia et al., 2024). In Oman traditional teaching methods remain prevalent which means educational culture will either promote or obstruct the spread of AI knowledge.

10.Propositions for Empirical Testing

- P1: The pedagogical adoption of AI will benefit from enhanced technological capability.
- P2: Improved technological capability leads to better student engagement.
- P3: A rise in technological capability will help institutions become better prepared.
- P4: The adoption of AI in teaching methods will lead to improved student engagement levels.
- P5: As pedagogical adoption of AI grows institutions will experience greater readiness.
- P6: When students actively use AI tools their engagement will promote institutional adjustments that showcase preparedness.
- P7: The impact of AI diffusion depends on educational culture which acts as a moderating force between technological capability and pedagogical adoption to shape student engagement.

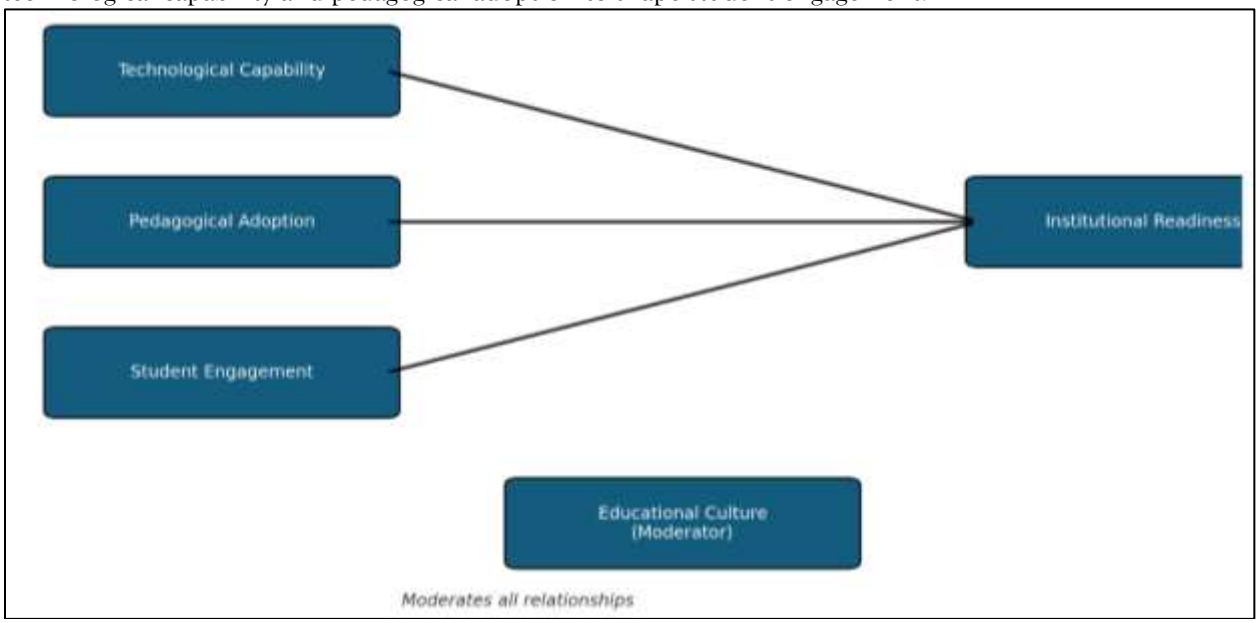

Figure 1. Conceptual Framework

11.Situating the Framework in the Literature & Benchmarking

The recommended conceptual framework provides a comprehensive methodology to study AI knowledge dissemination among higher education institutions with a particular emphasis on the context of Oman. The proposed framework integrates three renowned theoretical models TOE, UTAUT, and Constructivist Learning Theory into a unified system while connecting it to institutional preparedness and educational culture adjustments.

A. Comparison with Existing Models

The Technology Acceptance Model (TAM) and its variations receive widespread attention in research yet they mainly examine how users perceive and behave towards technology (Wang & Shin, 2022). Existing models generally fail to account for institutional structures and socio-cultural factors that influence educational reform according to Al-Adwan et al. (2023). By contrast, the proposed framework incorporates multi-level interaction: technological infrastructure, pedagogical behavior, and learner experience. Even though UTAUT examines adoption processes it fails to explain institutional scaling which this model successfully addresses (Pernaa et al., 2024).

Innovation models based on constructivist principles commonly focus on student-centered learning environments yet rarely investigate institutional scaling and support mechanisms (Cano & Nunez, 2024). TOE models excel at predicting technological trends yet they lack sensitivity towards teaching methods. This paper employs triangulated integration to deliver an enhanced framework which is both comprehensive and actionable.

B. Theoretical Contribution

The model advances theoretical understanding through three unique contributions.

1. Theoretical Convergence: The framework integrates behavioral with structural and cultural dimensions to meet the academic demands for comprehensive models (Zulu et al., 2023; Geng et al., 2023).
2. Localized Contextualization: This model addresses the lack of academic frameworks that are based in the Arab Gulf institutions which are shaped by Vision 2040 principles (Mutia et al., 2024; Zamani & Rousaki, 2024).
3. Cultural Moderation: The model presents a novel viewpoint on innovation diffusion discussions within traditional academic settings by using educational culture as a moderating factor (Prieto & Talukder, 2023).

C. Benchmarking and Global Alignment

Around the world higher education institutions using AI for learning focus mainly on infrastructure development while giving insufficient attention to pedagogical adjustments and institutional changes (Jo, 2024; Montenegro, 2024). The framework shows superior performance compared to existing models because it enables adaptability throughout different institutional layers. The framework enables UNESCO's digital transformation strategy by integrating lifelong learning with inclusive education approaches and strategic leadership principles (Field et al., 2021).

The newly proposed model distinguishes itself from Finland's, Singapore's, and South Korea's best-practice systems by emphasizing cultural alignment which makes it particularly suitable for Middle Eastern and emerging contexts (Wolbring & Gill, 2023).

D. Value Addition to Research and Practice

The framework provides academic understanding through a scalable mechanism-based model that adapts AI knowledge distribution for empirical research applications. The model helps researchers connect hypotheses and enables practitioners to develop programs that merge infrastructure design with teaching methods and cultural awareness. The framework proves its main strength through a combination of theoretical understanding and practical application.

12.Implementability, Environment & Adaptability

Achieving effective implementation of the AI knowledge diffusion and student innovation framework requires supportive institutional conditions together with appropriate policy environments and cultural sensitivity. This section examines operational needs and socio-cultural adaptations needed to implement the framework effectively in Oman's higher education institutions (HEIs).

A. Implementation Conditions

Higher education institutions that combine digital infrastructure with leadership dedication and academic freedom establish perfect conditions for effective implementation. Universities that run AI pilot projects via smart labs and e-learning platforms establish an advantageous position when they adopt this implementation model. Geng et al. Successful implementation requires the creation of an AI integration policy together with cross-functional innovation units and data governance structures. (2023) and Camilleri & Camilleri (2022). Educational institutions need to shift their perspective on AI from being a secondary tool to a fundamental driver of educational reform.

B. Enabling Environment

A strong policy directive such as Oman's Vision 2040 combined with leadership alignment and continuous faculty development forms the basis of the framework. Leaders of educational institutions should push AI integration by creating faculty incentives and starting pilot programs and by reshaping the curriculum based on research from Field et al. (2021) and Mutia et al. (2024). Teacher development programs must encompass both AI application techniques and analysis of educational consequences. Creating an enabling environment requires input from multiple stakeholders including students, faculty members, IT teams and policymakers.

C. Socio-Cultural Adaptation

This model functions effectively across different cultures once educational traditions are taken into account. The dominant teaching style of structured instruction in Oman and Gulf states presents obstacles to constructivist educational methods. Educational institutions must bridge traditional values with modern technology through culturally appropriate AI applications such as fusing AI learning tools with Islamic educational principles. The process of gaining stakeholder buy-in should remain culturally sensitive and take place incrementally through academic champions who build trust within the community.

D. Barriers & Preparation

Traditionalist faculty resistance along with fears about job displacement and inadequate confidence to operate AI tools represent major obstacles to implementation (Montenegro, 2024; Jo, 2024). Students may not have adequate digital literacy skills to experience the full benefits of AI-mediated educational environments. Organizations need to conduct baseline needs assessments and provide digital literacy training while engaging stakeholders before implementing AI systems in phases. Institutional implementation processes require feedback loops and continuous monitoring to make iterative adjustments that build momentum.

The framework moves beyond theoretical understanding to institutional application by integrating practical and environmental aspects with cultural elements which leads to culturally embedded AI innovations.

13.Experimental and Empirical Potential

The study's conceptual framework demonstrates academic foundations while remaining suitable for empirical testing. Researchers can convert the framework's variables and relationships into measurable constructs for academic research at HEIs in Oman and other emerging contexts through both quantitative and qualitative methodologies.

A. Empirical Application

The framework components which include technological capability, pedagogical adoption, student engagement and institutional readiness enable translation into survey instruments as well as interview guides and document analysis rubrics. Validated UTAUT-based survey items evaluate pedagogical adoption according to Pernaa et al. (2024), and TOE-inspired instruments measure technological readiness and capability as shown by Camilleri & Camilleri (2022) and Zulu et al. (2023). Audits of digital policies and governance procedures alongside leadership participation in AI initiatives reveal institutional readiness levels.

B. Experimental Designs

Longitudinal and quasi-experimental designs serve as suitable methodologies to investigate the impact of various interventions on student innovation throughout prolonged periods. One group of students or faculty members undergoes structured AI training while a separate group continues with traditional educational methods. Analysis of student engagement alongside institutional adoption practices and responses helps determine the effectiveness of the proposed framework (Geng et al., 2023; Jo, 2024). In field experiments researchers deploy AI tools within particular courses to track changes in students' creative and collaborative abilities together with their innovation skills.

C. Suggested Methods

Researchers should use mixed methods approaches to obtain comprehensive insights into how frameworks function across different dimensions. Through surveys researchers can measure adoption levels along with digital readiness and engagement while interviews and focus groups provide insights into cultural constraints and institutional experiences. Researchers use NVivo-based qualitative coding to discover themes about educational culture and organizational change together with structural equation modeling (SEM) to evaluate the power of presumed relationships (Çelebi & Pinar, 2024; Cano & Nunez, 2024).

D. Outcomes to Measure

The framework supports the assessment of multiple dependent outcomes including:

- How student innovation output increases through tangible results such as prototypes and AI projects.
- Change in faculty AI adoption levels
- Changes in institutional policy and strategic AI investments
- Student satisfaction and engagement with AI tools
- Evolution of organizational digital maturity

The results match Oman Vision 2040 targets related to boosting creative development and digital transformation to achieve knowledge economy growth (Field et al., 2021; Mutia et al., 2024). The framework offers a flexible guide through which researchers can conduct organized empirical research.

14.Limitations and Boundary Conditions

The proposed conceptual framework provides a new integrative method for understanding AI knowledge diffusion and student innovation but requires recognition of its limitations and clear identification of its applicable scope. Transparency in the research process bolsters academic integrity and guides subsequent scientific inquiries.

A. Conceptual Assumptions

The framework presumes HEIs in Oman have basic digital infrastructure and faculty who are literate in digital tools, but these conditions may not be consistent throughout all institutions. The model assumes that institutional leadership will embrace innovation and policy changes, but this may not be true in bureaucratic or resource-poor institutions (Jo, 2024; Montenegro, 2024). The model operates on the belief that educational culture can be moderated and adjusted but remains flexible enough for change which does not apply across all academic environments. Institutional readiness assumes administrative unity which often shows significant differences within a single institution.

B. Scope and Boundaries

The framework is specifically designed for higher education institutions situated in emerging economies with a particular focus on those operating in the Gulf Cooperation Council (GCC) region. The framework does not apply well to primary and secondary schools or autonomous research institutions located in the Global North. The focus on Vision 2040 combined with Arab cultural elements requires adaptation of the model for use in societies that are neither Muslim nor Arab according to Zamani & Rousaki (2024) and Mutia et al. (2024).

Furthermore, this is a conceptual model. The model is based on empirical discoveries but lacks testing in different institutional environments and longitudinal studies. The interaction effects that involve the moderating influence of educational culture need empirical validation. The current model lacks mechanisms to incorporate external shocks such as geopolitical events and pandemics which can speed up or impede AI adoption alongside knowledge transfer.

The framework serves as a solid foundational perspective which researchers can adjust and grow through empirical studies and comparative evaluations.

15.CONCLUSION

This research study presents an innovative integrated framework to study the impact of AI knowledge distribution on student creativity at universities in Oman. This framework combines the principles of TOE, UTAUT and Constructivist Learning theories with institutional readiness as a contextual factor and educational culture as a moderating influence. Within institutional innovation ecosystems digital infrastructure interacts with faculty behavior and student engagement to shape educational environments.

This research contributes to educational AI studies by examining basic theoretical concepts and addressing research gaps before providing a model that can undergo empirical evaluation. By integrating behavioral, structural and contextual aspects this new framework enhances theoretical understanding and delivers guidelines to practitioners for developing AI strategies compatible with institutional abilities and cultural environments.

The framework enables researchers to use mixed-methods techniques for experimental validation from various perspectives. The framework provides decision-makers and institutional leaders with a practical tool to synchronize their AI implementation strategies with Oman Vision 2040 national development goals. The framework shows its value by being applied to educational systems throughout the Gulf region plus systems emerging beyond national borders.

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