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Learning Analytics and Knowledge Management Systems for Higher Education

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ABSTRACT

The proposed research investigates the impact of communication technologies and information systems on knowledge management in e-learning environments. The authors leverage the established models of Nonaka & Takeuchi and Harsh (including knowledge reusability and sharing in a 3D context) to explore this relationship. Their findings suggest that incorporating knowledge sharing and reusability significantly enhances e-learning effectiveness. Furthermore, research indicates that data analytics (DA) presents a valuable tool for enriching the learning experience. DA facilitates the discovery of new learning areas and fosters qualitative learning within higher education. This is achieved through its extensive capabilities in analyzing existing knowledge. To ensure the inclusion of quality knowledge, the well-regarded Approach- Deploy-Review-Improve (ADRI) model is also considered. Finally, the potential of knowledge repositories in diverse educational settings is emphasized.

Keywords: E-learning, Data Analytics, Knowledge Management, Artificial Intelligence.

INTRODUCTION

The rise of web technology in recent years, as evidenced by various applications [2, 5], has fundamentally changed learning. However, this integration of technology, human interaction, and management presents unique challenges for e-learning systems. These challenges require careful consideration to ensure successful development.

While e-learning systems offer the advantage of accessing vast amounts of information anytime, anywhere (like browsing a website) [replaces "Using the E systems..."), a key focus for researchers is creating effective systems that deliver high-quality content.

Furthermore, fostering collaboration and cooperation is essential. Ideally, e-learning systems should provide the tools necessary to build online communities where students can share their expertise and resources, fostering a richer learning experience.

Learning Management Systems

Investigating the Best E-Learning Systems

This research explores how to create the best e-learning management system. We propose using a web-based system to integrate data and metadata from existing e-learning environments. This approach leverages web

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technologies to access and compare metadata across different platforms. Furthermore, such systems can be used to design learning materials that foster a comparative and informative learning experience.

Our core focus is on understanding how technological infrastructure in a modern web environment influences knowledge acquisition and reusability within the learning process. Additionally, we will examine how the quality of knowledge impacts learning effectiveness, using the established ADRI model as a reference point.

Building Effective E-Learning Systems

Developing successful e-learning systems requires careful consideration of various factors. Technological choices must facilitate the integration of multiple processes involved in online learning. Access to trained human resources and a suitable web environment are also crucial. To achieve this, a holistic approach is needed, encompassing technical skills like computing, networking, and internet communication.

A Three-Dimensional Model for Web-Based Learning

Hanson et al. [4] proposed a three-dimensional model (Figure 1) that highlights the importance of human interaction, technology, and management in building effective web-based information systems. This model identifies management skills as central to coordinating, regulating, and integrating web systems with existing organizational structures. Technical skills, according to the model, encompass computing, networking, and internet communication, while human interaction skills involve graphic design, communication, and presentation.

Figure 1 Difference between Data analysis and data analytics

Figure 1 shows some of the options from a sample system, which facilitate the data analytics for a better management of the classroom teaching and assessment handling. Likewise there are many tools and options

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available which support the faculty in their day to day activities to manage the cohort.

Figure 2 Qualitative data analytics samples

Figure 2 talks about some of the qualitative feedback which can be helpful for the faculty in improving the learning experience. According to the authors, the quality of the information derived totally rests upon the issues related to technology, human interaction and management. Building Effective E-Learning Systems

Building successful e-learning systems requires a multifaceted approach. As highlighted by Hanson et al. [4], three key areas are crucial: human interaction, technology, and management. These areas represent the essential skillsets needed to develop effective web-based information systems that support e-learning.

To assess the quality of such systems, this research proposes utilizing the ADRI model (Approach, Deployment, Results, Improvement) suggested by Alani et al. [1]. Jantti [3] further emphasizes the effectiveness of the ADRI model in evaluating the alignment between objectives and achieved results. The model prompts a series of questions:

What are the intended outcomes of the chosen approach?

What resources are necessary for implementation?

How and when will the approach be deployed?

What were the actual results achieved?

Did these results directly stem from the deployed approach?

What areas require improvement for future iterations?

By employing the ADRI framework, we can systematically evaluate the effectiveness of our e- learning systems and identify areas for improvement.

Introduction and Background

In today's rapidly evolving global economy, knowledge management has become a key differentiator for organizations. Businesses are increasingly focused on identifying and sharing the expertise of their employees

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[6, 7]. This involves electronically capturing and managing knowledge to unlock hidden ideas and assets within the organization [8].

However, managing knowledge effectively can be challenging. Krog et al. [9] highlight the importance of behavioral factors in knowledge sharing, particularly within open-source software projects.

Multi-Layered Knowledge and Organizational Capabilities

Kusunoki and Nonaka [10] propose a multi-layered structure of knowledge to describe an organization's capabilities. They identify three distinct layers, each with its own potential:

Individual knowledge: This layer encompasses specific skills and expertise within a group orindividual, such as functional knowledge of engineers.

Collective knowledge: This layer represents knowledge shared and embedded within a team or department, often captured in databases or patents.

While technology plays a significant role in managing and searching for explicit knowledge (e.g., documents in databases), Kusunoki and Nonaka emphasize the importance of knowledge creation through reusable assets and repositories. This could involve sharing best practices or documents within a central location to facilitate faster knowledge development.

Nonaka Model and Learning

Effective Knowledge Management for E-Learning Systems, Successful knowledge management for e-learning systems requires a comprehensive approach. Several factors need to be considered, including technology, human resource practices, organizational structure, and culture. This ensures that the right knowledge is delivered to the right learner at the right time.

The Role of User-Centered Design

We propose that an ideal web-based information system for e-learning should prioritize quality in four key areas: analytical thinking, data, information, and knowledge.

Achieving this quality balance requires effective user-centered design, which emphasizes user needsthroughout the development process. As illustrated in Figure 3 (not shown here), this iterativedesign cycle involves:

Evaluation: Assessing the existing design's strengths and weaknesses. Redesign: Addressing usability issues identified in the evaluation stage. Evaluation: Comparing the redesigned system against the original version.

Qualitative vs. Quantitative Research

Both qualitative and quantitative research methodologies can be employed at different stages of the design cycle. Qualitative methods, such as user interviews and usability testing with a small group, are particularly valuable during the redesign phase. These methods help identify major usability problems quickly and cost-effectively.

Nielsen's Law of Usability, which suggests that 85% of usability issues can be uncovered with just 5 users (assuming the design isn't already near perfect), highlights the effectiveness of this approach.

Quantitative methods, on the other hand, are better suited for measuring specific improvements or linking design changes to concrete outcomes. These methods are often used by organizations with more mature UX

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practices to track usability metrics and benchmark design iterations.

By employing a user-centered design approach that leverages both qualitative and quantitative research methods, we can develop e-learning systems that effectively manage knowledge and deliver high-quality learning experiences.

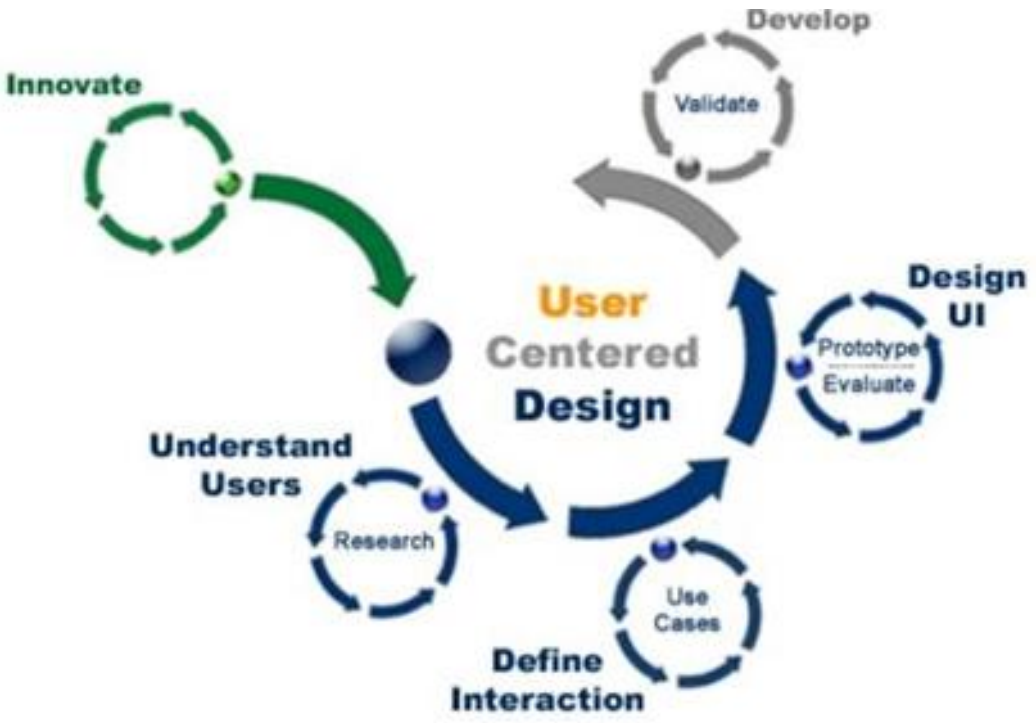

Figure 3 User-centered design cycle:

A prominent knowledge management model in the field is the one developed by Nonaka and Takeuchi [11]. This model proposes four knowledge conversion styles within a two-dimensional environment. These styles involve converting tacit knowledge (implicit, experiential) to explicit knowledge (documented, codified) and vice versa.

Author expands on this concept by suggesting that similar knowledge transformation processes can occur in a three-dimensional environment. He further proposes a three-dimensional model encompassing data, information, knowledge, and knowledge reuse. Notably, author emphasizes that data and information reuse contribute to creating higher-quality knowledge and increasing confidence in its application due to repeated use.

Building upon Nonaka's concept of a knowledge creation spiral [11, 12], Harsh suggests that knowledge in a web environment follows a similar cyclical process. This process involves four key activities, as illustrated in Figure 4 (not shown here):

Socialization: Sharing tacit knowledge through interaction and collaboration.

Externalization: Converting tacit knowledge into explicit knowledge through documentation or communication.

Internalization: Transforming explicit knowledge into tacit knowledge through individual learning and experience.

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Combination: Integrating existing knowledge (explicit and tacit) to create new knowledge.:

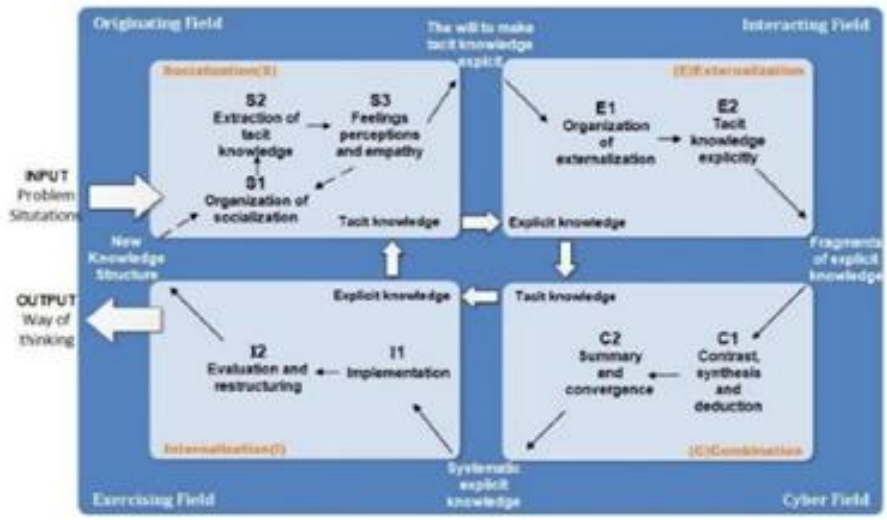

Figure 4- Nonaka's Model of Knowledge Conversion (Tacit vs. Explicit)

The Value of Data, Information, and Knowledge in E-Learning, We argue that the true value of data, information, and knowledge in a web-learning environment lies in their application and reuse. This fosters transparency for learners by providing clear access to these resources. Furthermore, successful e-learning systems must consider the factors outlined in the Hansen model [4]: technology, management, and human interaction. This three-dimensional approach ensures that learners (the human element) can engage and interact effectively within the learning environment. Here, human interaction (learner interaction) is not treated as isolated, but rather integrated with the other elements for a holistic learning experience. Nonaka's Model and Collaborative Learning- Nonaka's model [12] emphasizes the connection between individual learners and organizational learning. This suggests that organizational knowledge creation occurs through interactions between individuals and groups. This collaborative aspect aligns with the principles of Laurillard's Conversational Framework

for Learning.

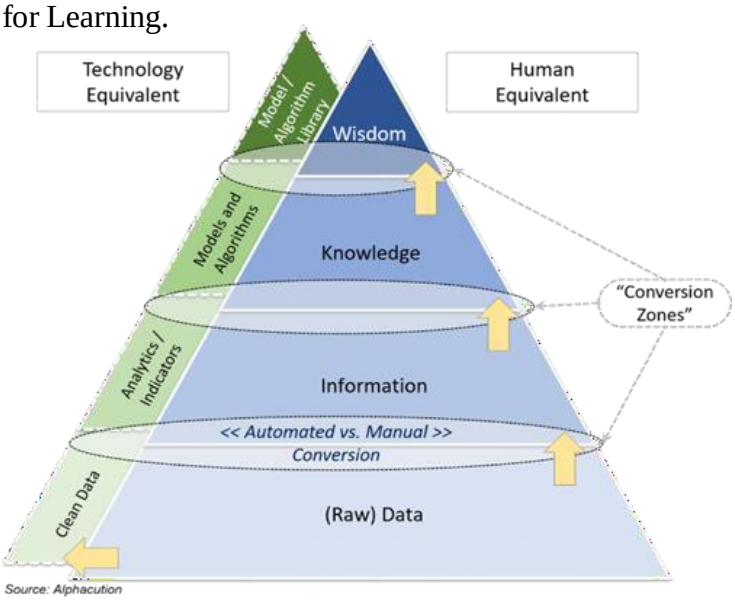

Figure5- The DIKW Framework for Continuous Learning and Adaptation

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The DIKW Pyramid and E-Learning

The DIKW pyramid (also known as the data pyramid, information pyramid, or knowledge hierarchy) is a model that depicts the relationship between data, information, knowledge, and wisdom [Figure 5 - not shown here]. Information is essentially processed data, knowledge is processed information, and wisdom represents the application of knowledge with experience and understanding.

This progression highlights the importance of building a strong foundation in e-learning. Learners need to start with a solid grasp of data (facts) before progressing to information, knowledge, and ultimately, wisdom.

E-Learning Environment and Quality

An ideal web-based learning environment should be transparent, allowing learners to interact and collaborate effectively. Additionally, the reusability of data, information, and knowledge plays a crucial role. This aligns with the principles of the ADRI model (Approach, Deployment, Results, Improvement) [reference source]. Quality is not only important for effective management of learning resources but also paramount for creating a successful learning experience for students.

I. E-LEARNING IN UNIVERSITY TEACHING Enhancing University Education with E-Learning

This paper explores how e-learning can improve university teaching. By incorporating Hanson et al.'s model [4], which emphasizes technology, human interaction, and management, e-learning offers several advantages.

Benefits of E-Learning

Flexibility: Students can customize their learning experience by accessing web-based systems and interacting with discussion forums or groups anytime, regardless of location or background.

Improved Knowledge Networks: E-learning fosters continuous growth in knowledge networks, aligning with the principles of the Nonaka model [11, 12] and the ADRI quality model.

Knowledge Transformation and Quality

The knowledge conversion processes outlined by Nonaka [11, 12] are compatible with the ADRI model, ensuring quality throughout the transformation of knowledge from tacit (implicit) to explicit (codified) and vice versa. These transformations are further facilitated by Hansen's model [4], which emphasizes the effective use of technology, management, and their interaction during web- based learning implementation.

Transparency and Accessibility

E-learning creates a transparent learning environment where technology, management, and their interaction are accessible irrespective of location or time. This allows learners to leverage all available learning resources, regardless of their physical presence.

Knowledge Creation and Transfer

This approach promotes quality knowledge creation and transfer (as emphasized by the ADRI model) in a continuous, upward spiral (like a cone, as suggested by Harsh [13-17]). This ensures the effective transfer of knowledge from teachers to learners, incorporating all aspects of technology, human interaction, and management.

The Role of Knowledge Reusability

A key innovation of this research is the integration of knowledge reusability within the refined Nonaka model

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(presented by Harsh [13-17]) and the considerations of Hansen et al. [4]. This comprehensive approach allows for the transfer and conversion of knowledge in a reusable format, applicable to various web-based learning scenarios. Reusable knowledge not only boosts learner confidence but also creates a more qualitative learning environment due to its established usefulness in diverse contexts.

Global Learning Environment

This approach fosters a uniform, reusable, and manageable learning environment for learners and teachers worldwide. It reduces the challenges associated with language barriers by providing a common ground for interaction. Additionally, it facilitates the creation of reusable knowledge components that can be explored and adapted for future use in various situations.

Building a Knowledge Repository

In the broader context, this research paves the way for creating a repository or library of reusable knowledge components and associated vocabulary. This facilitates the effective management of both data and metadata within the learning system.

Implementation and Pilot Testing

Higher education institutions can create suitable infrastructure to accommodate these proposed functionalities. Pilot testing can be conducted before full-scale implementation to ensure system effectiveness.

Ubiquitous Knowledge Conversion

The four modes of knowledge conversion, depicted in Figure 2 (not shown here), align with the ADRI model [3, 11, 12] and are crucial for the successful operation of contemporary universities. Hansen et al.'s model [4] further ensures that these conversion modes are interactive, manageable, and accessible to all learners.

Integrating Key Elements

This research represents the first attempt to integrate technology, knowledge reusability, human interaction, quality considerations, and knowledge conversion processes within a single, location- independent model. Experimenting with this model can create significant and widespread learning opportunities for students and educational institutions alike.

Interactive and Reusable Learning Environment

The model allows teachers to explore complex problems by experimenting with students. This creates a highly interactive and valuable e-learning environment where learners can collaborate using a simple and reusable language. Ultimately, this approach facilitates smooth interaction, interpretation, and knowledge sharing among students and teachers.

CONCLUSION

In this research authors have explored the potential of managing e-learning environments in higher education using two frameworks:

Nonaka's Model: This model describes the transformation of knowledge between tacit (implicit) and explicit (codified) forms [11, 12].

ADRI Model: This model emphasizes quality assurance throughout various stages of a process [3].

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The combination of these frameworks suggests the possibility of achieving high-quality knowledge management within e-learning settings.

INSPIRING FUTURE RESEARCH

This study offers several promising avenues for further investigation: Innovation and Knowledge Types: Contrary to previous theories, our findings suggest that innovation is not necessarily linkedto specific types of knowledge transformation (transformative vs. transfer). Future research should explore the relationship between innovation and both the generation (e.g., creativity) and implementation stages (e.g., launching new products or services).

Multilevel Analysis: Future studies could benefit from a multilevel approach, examining the model's underlying assumptions (ontology) and the shared understanding within teams collaborating on e-learning initiatives.

By addressing the questions raised in this research, we can pave the way for further experimentation with relevant models and create even more effective e-learning environments.

REFERENCES

1. M. A. Job and J. Pandey, "Academic Performance Analysis Framework for Higher Education by Applying Data Mining Techniques," 2020 8th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO), 2020, pp. 1145-1149, doi: 10.1109/ICRITO48877.2020.9197925.
2. F. Coda,, C. Ghezzi, , G. Vigna, & F. Garzotto, (1998), "Towards a software engineering approach to web site development", in: Proceedings of the 9th International Workshop on Software Specification and Design, 20th International Conference on Software Engineering, Kyoto (Japan), April 1998, pp. 8-17.
3. M. H., Jantti, Minding your own business: can a business excellence framework translate to the education sector?, in Quality conversations: proceedings of the Annual Higher Education Research and Development Society of Australasia Conference, 25th Annual International HERDSA Conference, Perth, 7-10 July 2002.
4. Hanson, Steve, Deshpande, Yogesh and Murugusan, San, A Skills Hierarchy for Web Information System Development: http://www.serveyor.com/misc/docs/A Skills Hierarchy for Web Information Systems.pdf
5. Pressman, R. S., 'What a tangled web we weave', IEEE Software, 17 1, January, 2000.
6. G. M. Steyn, "Creating Knowledge Through Management Education: A Case Study of Human
7. Resources" Management. Education, 123(3), 514-531,2002.
8. M. Martensson, "A critical review of knowledge management as a management tool." Journal of Knowledge Management, 4(3), 204-212, 2000.
9. K. Eginton, (1998). Knowledge management – law firms can do it too. Australian Law Librarian, 6, 247-255.
10. Krogh, George von, Spaeth, Sestian and Haefliger, Stefan "Knowledge Reuse in Open Source, 2005. Software: An Exploratory Study of 15 Open Source Projects", Proceedings of the 38th Hawaii International onference on Systems Sciences, 1-9.
11. K. Kusunoki, and I. Nonaka, "Organizational Capabilities in Product Development of Japanese Firms: A Conceptual Framework and Empirical Findings." Organizational Science 9(6), 1998.
12. I. Nonaka, And H. Takeuchi, "The Knowledge Creating Company: How Japanese Companies Create the Dynamics Of Innovation", New York, Oxford University Press, 1995 Computer Science, Vol.1565, 23 -143, 1995.
13. I. Nonaka, The Concept of Building a Foundation for Knowledge Creation. California Management Review Spring 1998 (Special Issue of Knowledge and the Firm).