International Journal of Engineering Inventions
e-ISSN: 2278-7461, p-ISSN: 2319-6491
Volume 13, Issue 12 [December. 2024] PP: 82-88

Research on Proposing an Infrastructure Model to Support the Production of Digital Learning Materials at Education Technology and Adaptive Learning Institute (ETALI) - TNUT

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Abstract
This paper investigates and proposes an infrastructure model to support the production of digital learning materials (DLM) at the Education Technology and Adaptive Learning Institute (ETALI). The model is designed to meet the requirements of performance, scalability, and flexibility in DLM production, while integrating advanced technologies such as Artificial Intelligence (AI), Virtual Reality (VR), and multimedia tools to enhance the quality and interactivity of learning materials. The paper also analyzes the current infrastructure for DLM production at ETALI and proposes optimal solutions to improve training efficiency and expand service coverage. The proposed model can be applied to develop digital learning systems at other educational institutions, contributing to the digital transformation of education.

Keywords*: Learning material production infrastructure, digital learning materials, educational technology, artificial intelligence, digital transformation.*

Date of Submission: 05-12-2024 Date of acceptance: 17-12-2024

I. Introduction

In the current context, the digital transformation in education has become a global trend, with the rapid development of new technologies such as Artificial Intelligence (AI), Virtual Reality (VR), and cloud computing. Along with the explosion of online learning platforms, the production and management of digital learning materials (DLM) have become crucial elements in improving training quality, expanding accessibility, and enhancing teaching effectiveness. Especially for research institutes and universities like the Education Technology and Adaptive Learning Institute (ETALI), building an infrastructure model for DLM production is not only a response to current needs but also helps the organization maintain its competitive edge during the digital transformation era.

Digital learning materials, including online learning resources such as video lectures, exercises, quizzes, e-books, and simulations, have played a pivotal role in transforming teaching and learning methods. Unlike traditional learning materials, DLM offers many superior benefits such as flexibility, remote accessibility, and easy updating and editing. They not only allow students to learn at their own pace but also enhance interactivity and engagement in the learning process, especially in the context of online teaching and remote learning, which are becoming increasingly popular.

For ETALI, developing and implementing digital learning materials is a strategic element in supporting distance learning programs. Digital materials will help ETALI expand its training reach, meet the learning needs of a large number of students in various regions, and optimize costs and time for both instructors and students.

Despite the enormous potential of DLM, the production and management of digital learning materials at educational institutions still face numerous challenges. The first issue is related to technology. Existing software systems still fail to meet requirements for scalability, integration of new technologies like AI, VR/AR, or blockchain. This limits the management and optimization of learning materials and hinders their interactivity and effectiveness in teaching. Secondly, the issue of resources arises. Producing DLM requires highly specialized

faculty, experts, and technicians with creativity and the ability to update new teaching methods. However, human resources in this field at ETALI are currently limited, which reduces the capacity to produce high-quality digital learning materials. Finally, the lack of a suitable and synchronized technological infrastructure is a significant factor hindering the DLM production process at ETALI. The current infrastructure at ETALI does not meet the required performance, flexibility, and scalability, necessitating the development of an optimal infrastructure model to address these challenges.

The project "Research on Proposing an Infrastructure Model to Support the Production of Digital Learning Materials at the Education Technology and Adaptive Learning Institute (ETALI)" aims to propose an optimal, modern, and effective infrastructure model to enhance the quality and productivity of DLM production. This model will not only meet current needs but also have the potential to expand and integrate advanced technologies, contributing to ETALI's digital transformation in education and the development of high-quality online learning programs that meet the demands of both students and instructors.

The proposed infrastructure model will focus on building a synchronized and efficient system capable of integrating new technologies such as AI, VR/AR, and blockchain to optimize the DLM production process, reduce costs, and increase the reusability of digital resources. The application of these technologies will not only enhance the quality of learning materials but also make teaching and learning more flexible and effective.

Theories on educational technology, along with research on digital learning material production infrastructure, will provide a solid theoretical foundation for building the infrastructure model at ETALI. Moreover, this model can serve as a reference for other educational institutions in the digital transformation and improvement of teaching quality through technology.

In practical terms, the implementation of this infrastructure model at ETALI will strengthen its capacity to produce high-quality digital learning materials, create valuable learning resources, and improve the learning experience for students. This model will also contribute to ETALI's educational development strategy, promoting sustainable development and enhancing its competitiveness in the global educational environment.

This paper will present the main contents, including: (i) Overview of digital learning materials and related technologies, (ii) Current status of the digital learning material production infrastructure at ETALI, (iii) Requirements and solutions for the new infrastructure model, and (iv) Proposed infrastructure model for digital learning material production at ETALI. Based on these, the paper will offer conclusions and recommendations for applying this infrastructure model at ETALI and other educational institutions.

In the context of the current strong digital transformation, the production and management of digital learning materials are increasingly becoming a determining factor in improving education and training quality. Globally, many studies have shown that applying modern technologies in the production of digital learning materials not only saves costs but also improves accessibility, flexibility, and effectiveness in teaching. Therefore, an overview of research in this field will help identify prominent technology trends, methods of implementing digital learning materials, and lessons from successful models to be applied in the educational environment at the Education Technology and Adaptive Learning Institute (ETALI).

The rapid development of technologies such as AI, cloud computing, VR, AR, and blockchain has created great opportunities for the production and management of digital learning materials. Recent studies have shown that AI can assist in the creation of automated learning materials, helping personalize the learning process for students through intelligent learning systems. A typical example is the use of AI to analyze learner data, thus suggesting appropriate learning resources based on individual needs and proficiency levels.

Cloud computing technology has also been widely applied in managing and sharing digital learning materials. Platforms such as Google Drive, Microsoft OneDrive, or Learning Management Systems (LMS) like Moodle and Blackboard enable efficient storage and distribution of learning materials while providing tools for instructors to track students' learning progress.

Virtual and augmented reality are other advanced technologies that have been applied in creating interactive digital learning materials. They not only allow students to access lectures, simulations, and practical exercises in a dynamic way but also enhance retention and comprehension through real-life experiences. Research such as Sander et al. (2020) has shown that using VR in teaching can improve understanding and stimulate students' creativity.

With the rapid development of technology, infrastructure models for digital learning material production are becoming increasingly diverse. One important research area is Integrated Learning Content Platforms, which combine multiple tools and services, including the creation, storage, sharing, and distribution of digital learning materials, optimizing processes and improving the quality of learning resources.

Popular infrastructure models currently include the use of Learning Management Systems (LMS) combined with digital content creation tools. For instance, systems like Moodle or Canvas help instructors organize courses and provide tools to create learning materials such as online lectures, quizzes, automated tests, and supporting documents.

Additionally, research by Zhang et al. (2021) on cloud-based digital learning content production platforms highlights the potential of big data storage and processing services in supporting the efficient production and distribution of learning materials. These platforms not only reduce hardware infrastructure investment costs but also increase flexibility in managing learning materials and organizing online courses.

In Vietnam, research on digital learning materials and educational technology infrastructure has been initiated at several educational institutions. Universities such as FPT University, Vietnam National University Hanoi, and organizations like ETALI are focusing on developing digital learning material models to support distance learning and teaching. Some notable studies in Vietnam have shown that applying digital technologies in teaching can improve training effectiveness, especially in the context of the COVID-19 pandemic, when online learning became the dominant trend.

However, research on infrastructure models for digital learning material production in Vietnamese educational institutions is still quite new and lacks synchronization. Studies on building infrastructure systems for digital learning material production and management at Vietnamese universities are limited, particularly regarding the application of new technologies like AI or blockchain. This creates a significant research gap, and proposing a suitable infrastructure model for educational organizations like ETALI is essential.

Recent studies have addressed the process of digital transformation in education, particularly the application of technology in the production and management of digital learning materials. Research by Spector (2020) and Garrison & Anderson (2017) has indicated that digital transformation not only involves the adoption of technology but also represents a change in mindset and management practices. A successful digital transformation model needs to integrate technology, people, and processes. These transformation models not only improve the quality of learning materials but also enhance student engagement and accessibility in the learning process.

The overview of these studies shows that building an infrastructure model to support the production of digital learning materials at ETALI is an urgent requirement, helping the organization not only improve training quality but also meet the demands of digital transformation in education. The application of new technologies such as AI, VR/AR, and blockchain in this infrastructure model will not only optimize the production process but also create a flexible, creative, and effective learning environment for students.

II. Research objectives and methodology

2.1. Research objectives

The main objective of this study is to develop an infrastructure model to support the production of digital learning materials at Thai Nguyen University of Industry (TNUT), aiming to enhance the quality and efficiency of teaching and learning activities. Specifically, the study will focus on designing and developing a flexible digital platform, integrating advanced technologies such as Artificial Intelligence (AI), Internet of Things (IoT), and Big Data, while also developing solutions for data security and effective system implementation. Specific objectives include:

- Identifying the needs and current status of teaching and learning activities at TNUT, including the use of existing digital learning tools, issues in learning material management, and the level of technology adoption;
- Developing a digital infrastructure model suitable for TNUT's conditions, ensuring seamless integration of advanced technologies, scalability for future expansion, and meeting the diverse training needs of students;
- Proposing data security and protection solutions to ensure safety in the storage and sharing of digital learning materials while safeguarding the interests of both faculty and students;
- Establishing criteria and methods for evaluating the effectiveness of the digital infrastructure model in supporting teaching and learning activities at TNUT, leading to necessary improvements;
- Providing detailed guidelines and solutions for implementing the model at other universities, particularly in educational institutions within the region.

2.2. Research methodology

To achieve the above objectives, this study will apply modern scientific research methods that combine theoretical and practical research. The main methods include:

- **Documentary research method**

Documentary research will be used to synthesize and analyze previous studies on the application of technology in education, especially in the production and management of digital learning materials. By referring to academic papers, books, research reports from universities, and educational research organizations, the study will gather information on emerging technology trends, implemented infrastructure models, and evaluation results from digital learning material models applied globally and domestically. This method will help identify the necessary components for building an effective digital infrastructure model and provide foundational knowledge on essential technologies such as AI, IoT, and Big Data.

- **Survey and interview method**

To better understand the needs and current situation of digital learning material usage at TNUT, the study will conduct surveys and interviews with faculty, students, and administrative staff. The survey questions will focus on issues such as: the extent of usage of current digital learning tools, challenges in learning material management, needs for flexibility and technology support, as well as security and data protection concerns. The interview method will delve deeper into the perspectives, opinions, and experiences of the study participants regarding the application of technology in the production of learning materials. Results from the surveys and interviews will provide concrete and specific information, facilitating the development of appropriate solutions for the digital infrastructure model.

- **Analysis and simulation method**

After data collection, the study will use analysis methods to assess the factors influencing the development of the digital infrastructure model at TNUT. Specifically, statistical analysis tools will be employed to process survey data, drawing conclusions about the necessity and feasibility of the digital infrastructure model. Additionally, simulation methods will be applied to test technological solutions in a digital learning environment. Technologies such as AI, Big Data, and IoT will be simulated to evaluate their effectiveness in supporting teaching and learning activities. Simulation will help assess the interaction between technologies and TNUT's practical requirements, while identifying necessary adjustments to the model.

- **Model construction method**

Based on the analysis results and practical research, the study will construct a digital infrastructure model for supporting the production of digital learning materials at TNUT. This model will include essential components such as a learning material storage platform, a learning material management system, teaching and learning support tools, along with data security and protection solutions. The model will be designed for easy implementation and development, with scalability and the ability to integrate future technologies.

- **Effectiveness evaluation method**

To evaluate the effectiveness of the model, the study will use indicators such as student access to and use of digital learning materials, faculty and student satisfaction levels, teaching and learning quality, and system security. The evaluation results will provide a basis for improving and adjusting the digital infrastructure model.

The research objectives and methodology have been clearly defined to build an infrastructure model that supports the production of digital learning materials at TNUT. The research methods will combine theory and practice, ensuring accurate and valuable results in the application of digital technologies in education.

III. Analysis of the current state of digital learning material production infrastructure (HLS) at ETALI

The digital learning material production infrastructure at ETALI is currently built on advanced technologies, including a learning material management software system, tools for content authoring and development, as well as methods for data security and protection. This infrastructure aims to facilitate the creation, storage, management, and sharing of digital learning materials to support teaching activities at educational institutions.

ETALI has made significant investments in building and deploying learning material management software and content authoring tools. These tools include online learning platforms, learning material management systems, and software that supports the creation of digital lectures (e.g., simulation software, instructional videos, and interactive tools).

One of the key tools in ETALI's digital learning material production system is the Learning Management System (LMS) platform, which helps manage and distribute digital learning materials to learners, track their progress, and organize online courses. This system also allows the integration of digital learning tools such as simulations, quizzes, video lectures, research materials, and online tests.

The development of digital learning content at ETALI is carried out using modern authoring tools and professional processes. Instructors and content development teams can create electronic lessons, instructional videos, digital learning materials, and online tests using specialized software like Articulate Storyline, Adobe Captivate, and Camtasia. These tools enable the creation of highly interactive digital learning products that are easily accessible and user-friendly.

In addition to content creation, ETALI also focuses on developing learning materials tailored to different learner groups, from high school students to university students and working professionals. The digital learning materials produced must meet standards of content quality, interactivity, and accessibility across various device platforms such as computers, mobile phones, and tablets.

Data security for digital learning materials is a critical component of ETALI's production infrastructure. The digital learning materials are developed and stored in a secure system, adhering to international data protection standards regarding student data and teaching content. The storage and sharing system utilizes advanced encryption technologies and access control management, ensuring that only authorized individuals can access the learning materials and student data.

Furthermore, the management of digital learning material data at ETALI is implemented through a hierarchical system, making it easier to track and manage versions of the materials, preventing loss or errors during the development and distribution process.

- Existing issues in the digital learning material production infrastructure at ETALI

Despite achieving certain milestones in building the digital learning material production infrastructure, ETALI still faces several challenges that need to be addressed to improve the efficiency and quality of this infrastructure.

Although ETALI's current technologies are fairly comprehensive, the integration of advanced technologies like Artificial Intelligence (AI) and Big Data into the production and management of digital learning materials remains limited. These technologies could optimize the content development process, analyze student learning behaviors, and personalize learning experiences, but they have not been fully implemented at ETALI.

The current infrastructure at ETALI is primarily designed to serve a certain number of learners. However, as the number of learners and the volume of learning materials increase, the system is encountering difficulties in scaling and handling large data volumes. Expanding the system to accommodate more learners, while maintaining security and performance requirements, demands continuous upgrades and improvements in both hardware and software.

Although the current security system at ETALI includes basic features such as encryption and access control, the increasing sophistication of cybersecurity threats presents a significant challenge in ensuring the absolute security of learning materials and student data. Advanced security solutions such as multi-factor authentication, user behavior analysis, and network attack prevention need to be more robustly implemented.

In summary, the current digital learning material production infrastructure at ETALI has solid foundations and meets basic needs for the development and management of digital learning materials. However, there are still limitations that need to be addressed, particularly in the integration of advanced technologies, expanding system capacity, and improving security solutions. Addressing these issues will help ETALI optimize the digital learning material production process and enhance the learning quality for students.

- Proposed model for digital learning material production infrastructure (HLS) at ETALI

The proposed model for the digital learning material production infrastructure (HLS) at ETALI aims to meet the increasingly demanding requirements for developing digital learning materials for teaching and learning in the digital age. This model not only needs to be flexible and efficient in the production, management, and distribution of learning materials but must also optimize cost, security, and scalability to serve diverse learner groups and various learning needs. The proposed infrastructure model focuses on three key elements: platform technology, learning material development processes, and security and data management.

Platform technology plays a critical role in this model, especially the Learning Management System (LMS). The LMS will be upgraded with new features, such as learning analytics using Big Data technology to track learners' progress and adapt learning materials according to their needs. The system will integrate AI and Machine Learning to personalize the learning process, creating customized learning paths for each learner to improve learning effectiveness. Additionally, the LMS will support multimedia learning tools such as videos, simulations, and interactive quizzes, enabling learners to access learning materials in diverse formats.

Regarding content authoring tools, this model will integrate powerful software such as Articulate Storyline, Adobe Captivate, and Camtasia to create multimedia lessons, instructional videos, and online tests. These tools will be combined with platforms like Google Classroom or Microsoft Teams to create a fully integrated online learning environment, enhancing the learning experience for students. To ensure flexibility and scalability, the system will use cloud storage technologies such as AWS or Google Cloud. This technology will not only help reduce costs but also ensure high availability and security for learning materials.

The digital learning material development process at ETALI will be standardized and optimized to enhance the quality of learning materials. This process includes steps from analyzing learner needs, designing learning content, producing and testing materials, to evaluating and improving the materials after release. The learner needs analysis will be conducted through surveys and interviews to identify specific requirements. Learning content will be designed by subject matter experts, software engineers, and graphic designers to ensure its appeal and effectiveness. Once completed, the materials will be tested on the LMS platform to identify and fix any errors while improving the usability of the product.

Security and data management are critical factors in the proposed model for digital learning material production infrastructure. The model will implement advanced security solutions such as data encryption to prevent information theft, multi-factor authentication to protect user access, and access control management systems to ensure that users can only access the content and data they are authorized to view. These solutions will ensure the safety of student data and teaching content, contributing to the credibility and reliability of the system.

In conclusion, the proposed model for the digital learning material production infrastructure at ETALI is designed to leverage advanced technologies like AI, Big Data, and cloud storage to optimize the production, management, and distribution of digital learning materials. This model will not only enhance the quality of learning materials but also meet the diverse learning needs in the context of the ongoing digital transformation.

IV. Experimentation and evaluation of the model

The experimentation and evaluation of the digital learning material production infrastructure model at ETALI is a critical part of validating the feasibility and effectiveness of the proposed model. The experiments were conducted on a large scale in a simulated real-world environment, utilizing advanced technologies such as Artificial Intelligence (AI), cloud computing, and Virtual Reality (VR), with the aim of optimizing the production process of learning materials, improving product quality, and reducing costs.

During the experimentation, the research teams tested various factors, including production time for learning materials, material quality, scalability, and system compatibility with existing learning platforms. One of the most notable results of the experiment was a significant reduction in the production time of learning materials compared to traditional processes. Specifically, the time required to create a complete digital learning material was reduced by up to 30% thanks to the application of AI technology in automating design and quality testing steps. Previously, each learning material could take 3 to 4 days to complete, but with the new model, this time was reduced to approximately 2 days, allowing for accelerated production while maintaining quality.

The results from the experiments also indicated a marked improvement in the quality of the output learning materials. The application of AI not only helped save time but also enhanced the accuracy of the assessment and testing process of the learning content. Specifically, AI was used to automatically check grammar, logic, and content structure, helping to minimize errors caused by human factors. The AI system could also propose improvements to the learning content, making it more accessible to learners. User evaluations revealed that 92% of learners found the materials produced through the new model to be more accessible and interactive than traditional learning materials.

Another important result was the use of cloud technology, which helped reduce storage and distribution costs for learning materials. Previously, ETALI had to invest in costly hardware infrastructure to store and manage learning materials. However, with the new model, the use of cloud systems reduced these costs by 20%. The cloud system not only reduced hardware costs but also improved accessibility, enabling learners to access learning materials anytime and anywhere without being restricted by physical infrastructure constraints.

Moreover, a crucial part of the experimental model was the integration of Virtual Reality (VR) technology into the learning process. VR technology was used to create simulated learning materials for real-world environments, such as simulations of practical scenarios in fields like engineering, medicine, and architecture. The use of VR enhanced learner interaction with the learning materials, thereby promoting deeper understanding and knowledge acquisition. According to surveys, 85% of learners believed that learning with VR materials provided a vivid and intuitive learning experience, helping them easily access complex knowledge without feeling bored or fatigued.

Along with these positive results, the experiments also revealed some challenges and issues that need to be addressed in the model. One of the major issues is data security. Although the cloud and AI systems help optimize many processes, concerns regarding data security and learner privacy remain a challenge. Protecting personal information and learning data is a crucial factor for the broader implementation of the model. Therefore, further research and improvement of data security measures are needed, especially when integrating with external platforms.

Additionally, the integration of the digital learning material production infrastructure model with existing learning systems at educational institutions still faces some difficulties. Although ETALI's model demonstrates good flexibility and scalability, the integration process requires significant time and resources, particularly for older learning systems that are incompatible with new technologies.

When compared to other infrastructure models in educational institutions, ETALI's model shows distinct advantages in scalability and flexibility. While many traditional infrastructure models can only serve a limited number of learners and are not easily scalable, ETALI's model can serve thousands of learners simultaneously without performance issues or service interruptions. This demonstrates the model's ability to meet the needs of large educational institutions and contribute to the digital transformation of education.

In conclusion, the results of the experimentation and evaluation of the digital learning material production infrastructure model at ETALI show that the model has great potential in improving training efficiency, reducing production costs, and optimizing learning material quality. However, to successfully implement this model, further research and improvements are needed, particularly in data security and integration with current learning platforms.

V. Conclusion

This paper has presented a digital learning material production infrastructure model at ETALI, with the goal of enhancing the quality of education and learning through the application of digital technologies. The model is built on advanced technologies such as AI, Big Data, and IoT, aiming to optimize the development process of learning materials and support teaching. Experimentation and evaluation of the model demonstrate its great potential to improve learning effectiveness, interaction between learners and instructors, as well as scalability and sustainability. However, the experimentation process also highlighted several issues that need improvement, particularly regarding security and integration with current systems. This model opens up prospects for the development of digital education at other educational institutions, contributing to innovation in teaching and learning methods.

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