# CHAPTER ONE

# INTRODUCTION

# Background

In modern educational settings, the demand for effective instructional methods that enhance student comprehension and engagement, particularly in STEM (Science, Technology, Engineering, and Mathematics) education, has been steadily increasing. Traditional educational approaches often face challenges in conveying spatial or visual concepts, resulting in reduced comprehension and retention among learners (Smith, 2020).

Learning Management Systems (LMS) have emerged as vital tools in educational institutions, facilitating the management, delivery, and assessment of educational content. Over the years, LMS platforms have evolved from basic content repositories to comprehensive systems offering a wide range of features, including course management, collaboration tools, and assessment functionalities. Despite their widespread adoption, traditional LMS often lack the capability to effectively incorporate interactive and immersive learning experiences, particularly in disciplines that require visualization of complex concepts

(Parusheva, S., & Bankov, A. P. D. B. Learning Management Systems as a Tool for Learning in Higher Education.).

The integration of 3D model interaction into educational platforms has gained attention as a promising approach to address the limitations of traditional instructional methods. Research has shown that visualizing concepts in three dimensions can significantly enhance comprehension, engagement, and retention among learners, especially in STEM fields. By providing students with the ability to interact with 3D models within the learning environment, educators can create more immersive and impactful learning experiences (Lee, 2019).

The proposed project seeks to address the existing gap in educational technology by developing a prototype Learning Management System (LMS) with integrated 3D model interaction. By leveraging advancements in technology, particularly in 3D modeling and simulation, the project aims to enhance student comprehension of complex course content, particularly in STEM education. The integration of interactive 3D models into the LMS platform is expected to provide students with a more engaging, accessible, and effective learning experience, ultimately revolutionizing the way STEM subjects are taught and learned (Jones, 2021).

# Project motivation

Learners' especially in STEM fields struggle to comprehend complex concepts due to the limitation in traditional instructional materials (text and 2D visuals) which fail to convey certain spatial representation or understanding hindering comprehension and retention. Current learning management systems (LMS) often fail to utilize 3D models effectively. This project aims to develop an LMS platform that integrates 3D models to enhance the educational experience, empowering students to engage with course material more dynamically and effectively.

# Statement of problem

In modern educational environments, learners, especially in STEM fields, struggle to comprehend complex concepts due to limitations in traditional instructional materials. Textbooks and 2D visuals often fail to convey certain information effectively, hindering comprehension and retention. Existing learning management systems (LMS) lack the utilization of 3D models to enhance learning experiences. This project seeks to bridge this gap by creating an LMS platform that incorporates 3D models to improve comprehension, engagement, and retention among learners.

# Aim and objectives

The aim of this project is to develop a prototype LMS with 3D model integration to enhance comprehension of complex concepts especially in STEM (Science, Technology Engineering and Mathematics) fields, making learning more engaging and effective.

1. To design system architecture (flow charts, diagrams), UI/UX, database, API endpoints and technology stack and process to use for the LMS.
2. To develop a prototype of the LMS and integrate 3D models into the platform.
3. To test and evaluate software for requirements, and usability.

# Project organization

The project report is organized into five chapters.With chapter one giving a general introduction and overview of the project.

Chapter Two breifly discusses the relevant theoretical concepts and reviewed recent literature on Learning Management Systems (LMS) and the integration of 3D model interactions in educational platforms.

Chapter Three outlines the methodology or steps taken to actaulize set objectives of the project. Chapter four presents results obtained from each step from methodology, and discusses them in context of the set project objectives.

Chapter Five concludes and summarize the significance and limitations of integrating 3D models into LMS platforms, and suggesting areas for future research and development.

# CHAPTER TWO

# LITERATURE REVIEW

# Introduction

This chapter provides a concise overview of existing research and developments on learning management systems (LMS) 3D models, interaction and intergration. It outlines the current state-of-the-art technologies, explores their applications, and discusses the challenges and opportunities they present. By synthesizing relevant research, this review sets the stage for further exploration into the development of effective LMS with integrated 3D model interaction.

# Fundamental Concepts

This section discusses the fundamental concepts related to this work which includes LMS, 3D Models, WebGL, Web Programming, Web API, Javascript ( Next, React, Three ).

* 1. **LMS**

The Learning Management System (LMS) serves as a centralized platform for organizing and delivering educational content, facilitating learning activities, and managing student progress and assessment. It streamlines the administration of courses, allowing instructors to create and share course materials, assessments, and resources, while students can access content, participate in discussions, and track their learning progress.

(Parusheva, S., & Bankov, A. P. D. B. Learning Management Systems as a Tool for Learning in Higher Education.)

## 3D Models

3D Models, created using software like Blender, Unity, UnReal, AutoCard Maya, SolidWorks, etc are virtual objects comprising geometric shapes, textures, and visual properties, serving diverse purposes in gaming, animation, architecture, and education. These models are seamlessly integrated into web applications using 3D Model Integration Formats compatible with WebGL and Three.js, such as glTF, OBJ, FBX, Collada, and STL, each optimized for efficient loading and rendering. Enabling 3D Model Interaction within web environments allows users to manipulate and engage with models through actions like rotation, zooming, and animations, enhancing user experience in e-learning, product visualization, and virtual tours.

## WebGL

WebGL (Web Graphics Library) is a JavaScript API for rendering 2D and 3D graphics in web browsers, leveraging GPU acceleration for high-performance rendering. It enables developers to create visually rich and interactive web experiences, including games, simulations, data visualizations, and virtual reality applications (Mozilla Developer Network [MDN], n.d.-a).

Mozilla Developer Network [MDN]. (n.d.-a). WebGL API. Retrieved from https://developer.mozilla.org/en-US/docs/Web/API/WebGL\_API

## Web Programming

Web Programming refers to the development of web-based applications, websites, and services using programming languages such as HTML, CSS, JavaScript, and server-side languages like Python, Ruby, PHP, and Java. It involves designing, coding, testing, deploying, and maintaining web solutions to address various needs, from simple websites to complex web applications. Web programmers use frameworks, libraries, and tools to build interactive user interfaces, implement business logic, process data, and manage server-side functionality, ensuring the creation of functional, user-friendly, and reliable web experiences.(

Elakiya, K. (2023). A Comprehensive Review of Web Designing and Web Development: Concepts, Practices and Trends. International Journal of Research Publication and Reviews, 4(4), 2180-2182. Retrieved from [https://ijrpr.com/uploads/V4ISSUE4/IJRPR11646.pdf](https://ijrpr.com/uploads/V4ISSUE4/IJRPR11646.pdf" \t "/home/cyber3330d\\x/_new)

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## Web API

Web API (Application Programming Interface) defines interactions between different software systems over the web, allowing applications to communicate and exchange data. This enables integration with external services, access to web resources, and the creation of interactive web applications that interact with servers, databases, and other web services.

## Javascript ( Next, React, Three )

JavaScript, a versatile language integral to web development, facilitates interactive and dynamic web experiences through client-side scripting, DOM manipulation, event handling, and asynchronous programming. Complementing JavaScript, Next.js and React are frameworks for building dynamic web applications; React offers a component-based UI architecture, while Next.js extends it with server-side rendering, static site generation, and routing, streamlining complex app development (Next.js, n.d.). Additionally, Three.js, a popular JavaScript library built atop WebGL, simplifies 3D graphics creation and manipulation in web applications, providing a high-level API for rendering scenes, managing cameras, lights, materials, and animations, thereby enhancing developers' ability to work with 3D content on the web.

Next.js. (n.d.). Next.js - The React Framework. Retrieved from [https://nextjs.org/](https://nextjs.org/" \t "/home/cyber3330d\\x/_new)

## Software Development Life Cycle (SDLC)

The Software Development Life Cycle (SDLC) is a structured process used to guide the development of software applications from inception to retirement. It consists of several phases, including Requirements Analysis, Design, Implementation (Coding), Testing, Deployment, and Maintenance. Each phase of the SDLC has specific objectives and activities aimed at ensuring the successful delivery of high-quality software solutions. By following the SDLC, development teams can systematically plan, develop, test, deploy, and maintain software applications, ensuring they meet user needs, adhere to requirements, and align with business goals. The SDLC provides a framework for managing the software development process efficiently and effectively, resulting in the delivery of reliable and scalable software solutions.

# Review of similar literature

**Moodle: Dougiamas and Taylo**present Moodle, one of the most widely adopted open-source Learning Management Systems (LMS). The platform is designed to support a variety of functionalities including course management, user management, and assessment tools. The study details the system’s architecture and features, emphasizing its flexibility and extensibility, which have made it a popular choice in educational institutions worldwide. However, the paper points out that while Moodle is highly customizable, it requires technical expertise to tailor the system to specific institutional needs.

**Blackboard: Bradford et al. (2007)** describe Blackboard, a proprietary LMS extensively used in higher education. The authors highlight its comprehensive feature set, including content management, communication tools, and robust assessment capabilities. The study provides a detailed evaluation of Blackboard’s functionalities, focusing on its user-friendly interface and integration capabilities with other educational tools. Despite its widespread adoption, the paper notes that Blackboard’s high cost and proprietary nature can be a barrier for some institutions.

**Canvas: Kember (2010)** discusses Canvas, a modern, open-source LMS known for its user-friendly design and strong integration capabilities. The study explores Canvas’s architecture, emphasizing its cloud-based nature and ease of use. The paper praises Canvas for its intuitive interface and the ability to integrate seamlessly with various educational technologies, which enhances the learning experience. However, the study also highlights that while Canvas offers significant advantages, its relatively recent entry into the market means it lacks the extensive community support available to older platforms like Moodle.

**Virtual Reality in Education: Freina and Ott (2015)** investigate the application of virtual reality (VR) and 3D models in education, demonstrating their potential to improve student engagement and understanding of complex subjects. The paper provides an overview of VR technologies and discusses several case studies where VR was effectively used in classrooms. The results indicate that VR can enhance spatial awareness and interactive learning. However, the study notes the high cost and technical complexity of VR setups as potential drawbacks.

**Web-based 3D Visualization: DeLoura (2011)** explores the use of WebGL and Three.js for web-based 3D visualization. The study highlights the technical aspects of these technologies, showcasing their capability to render complex 3D models directly in web browsers without the need for plugins. The paper presents several educational applications, demonstrating how interactive 3D models can be integrated into online learning environments. While the technologies are powerful, the study acknowledges the challenges related to performance and browser compatibility.

Interactive Learning Environments: Perry et al. (2017) examine the integration of interactive 3D models in LMSs, focusing on their impact on STEM education. The study presents a detailed analysis of various implementations, showing that interactive 3D models can significantly improve learning outcomes by providing hands-on experience and better visualization of abstract concepts. The paper concludes that while the integration of 3D models is beneficial, it requires careful consideration of the pedagogical design to be effective.

**Augmented Reality (AR) in LMS: Chang et al. (2014)** explore the use of augmented reality (AR) within LMS platforms to enhance the learning experience. The study describes the development and implementation of AR applications that provide contextual 3D model interaction. The results indicate that AR can make learning more engaging and interactive, particularly in fields such as medical education and engineering. However, the study also highlights challenges such as the need for specialized hardware and potential user discomfort with prolonged AR use.

**Case Studies on 3D LMS Integration: Sotiriou and Bogner (2008)** present case studies on the integration of 3D anatomical models in medical education LMSs. The paper provides a detailed description of the development and implementation process, including technical and pedagogical considerations. The results show that 3D models can enhance understanding of complex anatomical structures and improve student engagement. However, the study points out the significant resources required for developing and maintaining high-quality 3D content.

**Unity and Unreal Engine: Anthes et al. (2016)** review the use of game development platforms like Unity and Unreal Engine in educational technology. The study explores how these platforms can be used to create immersive 3D environments and simulations for educational purposes. The paper presents several case studies demonstrating the effectiveness of these tools in enhancing learning experiences. However, the authors caution that the steep learning curve and resource-intensive nature of these platforms may limit their accessibility for some educators.

**Usability in LMS: Chua and Dyson (2004)** investigate the usability and user experience of LMS platforms, emphasizing the importance of intuitive design and user-centered development. The study provides a comprehensive analysis of various LMS interfaces, identifying key factors that contribute to effective usability. The results indicate that a well-designed user interface can significantly enhance the learning experience and user satisfaction. However, the study also highlights the need for continuous usability testing and iteration to address diverse user needs.

**Pedagogical Models: Mayer (2002)** discusses the integration of multimedia and interactive content in educational settings, focusing on the alignment with pedagogical models. The study provides a theoretical framework for designing educational content that leverages multimedia to enhance learning. The paper emphasizes the importance of aligning technological tools with pedagogical objectives to ensure effective learning outcomes. While the integration of multimedia can be highly beneficial, the study warns against the potential for cognitive overload if not carefully designed.

The development of an LMS with integrated 3D model interaction is supported by a substantial body of literature across several domains, including LMS platforms, 3D visualization in education, and the technological frameworks necessary for their implementation. These studies highlight the potential for such systems to enhance educational outcomes by providing immersive and interactive learning experiences. Future work in this area can build on these foundations to explore new applications and innovations in educational technology.

Li and Lin (2022) designed and evaluated a collaborative learning system for 3D model sharing, as reported in their chapter within the Research Anthology on Makerspaces and 3D Printing in Education. The study explored the increasing prevalence of 3D printing applications in education, noting the limitations of existing platforms for collaborative learning. The authors introduced the 3D Model Co-Learning Space (3D MCLS) system, tailored to address these limitations. This system allowed users to store, share, display, and discuss 3D models, with teachers having flexible management capabilities for student groups. Notably, the system automatically generated thumbnails for 3D models and utilized tags for organizing them into groups based on attributes or class teams. Additionally, it offered blind assignments for peer reviews. Li and Lin implemented the system and conducted a pilot study to evaluate its usability, providing valuable insights into its effectiveness.

Li, T. Y., & Lin, I. S. (2022). Design and Evaluation of a Collaborative Learning System for 3D Model Sharing. In Research Anthology on Makerspaces and 3D Printing in Education (pp. 165-188). IGI Global.

Husár, J., Knapčíková, L., Hrehová, S., & Trojanová, M. (2021) explored the development of a comprehensive Learning Management System (LMS) utilizing augmented reality applications, catering to the educational needs of university students. The article underscores the advantage of direct knowledge interpretation and 3D model visualization into the student's field of view, facilitated by interactive LMS Moodle in Microsoft HoloLens 2 smart glasses. The authors meticulously detail a step-by-step algorithm for integrating LMS Moodle with the Windows Holographic Operating System display interface, ushering in a new era of distance education. Through the Industry4School project, they curated a database of knowledge, tests, and models, culminating in a practical example of teaching in robotics and manipulators. The design's innovative feature allows for the simultaneous use of multiple windows spread across space, enabling students to engage with various educational tools concurrently, including notes, videos, internet resources, and 3D models. Emphasizing the application's utility in industrial management education, particularly in the context of Industry 4.0, the proposed LMS represents a significant advancement over conventional 2D education methods, enriching learning experiences by adding a third dimension and enhancing students' imagination.

Husár, J., Knapčíková, L., Hrehová, S., & Trojanová, M. (2021). The concept of the LMS system for teaching subjects from the field of Industry 4.0 based on augmented reality. In EDULEARN21 Proceedings (pp. 2779-2786). IATED.

Nemtinov et al. (Year) delved into the implementation of software tools in the educational process and their impact on the formation of students’ professional competencies. Their article underscores the necessity of considering this influence in the scientific and methodological support of modern education systems. The primary aim of their research is to develop a technology for creating educational VR content that enhances teaching effectiveness through immersion into a virtual thematic space using a variety of software environments. The authors discuss the technology's process, which involves creating an electronic course using a complex of specialized software tools. This process begins with developing a course description, followed by the utilization of three-dimensional models of virtual objects from software like SketchUp, Blender, Solidworks, and Compass-3D. The virtual space is then constructed in the Twinmotion software package using these models, alongside photorealistic panoramas, images, and videos. Subsequently, the virtual tour is created in 3DVista Virtual Tour Pro and integrated into the LMS Moodle learning management system. The authors tested the technology's implementation in creating educational content for the course "History of the Tambov Region," which demonstrated high efficiency based on survey results and testing outcomes. The study revealed a 17% increase in correct answers among students who used the proposed electronic content compared to those who did not. This suggests that the integrated use of specialized software tools enhances students' learning experiences and achievements while fostering teamwork and interpersonal communication skills through interactive lectures and group discussions.

Nemtinov, V. A., Rodina, A. A., Borisenko, A. B., Morozov, V. V., Protasova, Y. V., & Nemtinov, K. V. Integrated Use of Various Software Environments for Increasing the Level of Visualization and Perception of Information.

Hinojosa et al. (2021) highlighted the growing importance of quality virtual education, particularly in areas where face-to-face instruction is challenging, such as engineering laboratories. To address this, they proposed an augmented reality (AR) application designed to simulate elements and devices typically found in engineering laboratories. Developed using Unity and Vuforia software, the application is compatible with devices running the Android operating system or HoloLens. The authors conducted a case study focusing on virtualizing elements from telecommunications engineering laboratories and tested the application's usability with random users. Surveys were conducted to assess the application's impact on learning. Additionally, the authors provided a link for readers to download and install the application (.apk file) on their own Android devices, enabling them to explore examples firsthand. Hinojosa et al.'s work demonstrates the potential of AR-based e-learning tools to enhance virtual education experiences in engineering disciplines.

Hinojosa, C. J. T., Cabrera, J. J. F., Mora, H. R. C., & Garzón, N. V. O. (2021, May). An augmented reality based e-learning tool for engineering. In 2021 IEEE Colombian Conference on Communications and Computing (COLCOM) (pp. 1-6). IEEE.

Elfakki, Sghaier, and Alotaibi (2023) underscored the potential of virtual reality applications in enhancing the education and training of students with learning disabilities, ultimately improving their quality of life. Traditional teaching methods often fall short in adequately supporting students with learning disabilities, such as dyslexia, dyscalculia, ADHD, and information retrieval disabilities, particularly in subjects like physics where experiments play a crucial role. These disabilities hinder students' ability to learn, visualize concepts, and process information effectively. To address these challenges, the authors developed and evaluated a 3D virtual physics laboratory tailored specifically for students with learning disabilities. The environment, designed based on specific criteria for disabled students, aimed to improve cognitive skills in physics experiments. The study demonstrated the effectiveness of the 3D virtual environment in enhancing cognitive skills related to physics among students with learning disabilities. Elfakki et al.'s research highlights the potential of virtual environments to provide tailored educational experiences for students with diverse learning needs.

Elfakki, A. O., Sghaier, S., & Alotaibi, A. A. (2023). An efficient system based on experimental laboratory in 3D virtual environment for students with learning disabilities. Electronics, 12(4), 989.

Amara et al. (2021) addressed the significant disruption caused by the COVID-19 pandemic in the education system and proposed e-learning as a viable solution. Their paper advocates for the implementation of an e-learning platform based on 3D interaction using augmented reality (AR) and virtual reality (VR) to meet specific learning objectives and ease administrative burdens in schools. The platform aims to facilitate the teaching process by leveraging AR and VR technologies to visualize complex concepts that may be challenging to explain in traditional classrooms or textbooks. Through immersive environments and realistic 3D models, VR enhances the presentation of concepts and skills, making learning more interactive and engaging. The authors' main contribution lies in integrating AR and VR interaction into web-based education, offering courses and exercises aligned with the Algerian Ministry of Education's curriculum. By incorporating VR and AR into education, Amara et al. aim to increase participation and improve understanding, particularly in abstract and complex subjects.

Amara, K., Zenati, N., Djekoune, O., Anane, M., Aissaoui, I. K., & Bedla, H. R. (2021, November). I-DERASSA: E-learning Platform based on Augmented and Virtual Reality interaction for Education and Training. In 2021 International Conference on Artificial Intelligence for Cyber Security Systems and Privacy (AI-CSP) (pp. 1-9). IEEE.

Karagöz et al. (2023) emphasized the significance of student-content interaction in achieving successful outcomes in electronic learning environments. They highlighted the importance of using engaging content to strengthen this interaction, leveraging the digital transformation in the publishing industry to introduce Interactive Electronic Books (IEB) as educational materials accessible through various smart devices. IEBs integrate technologies like Augmented Reality (AR), 3D animation, and video files, enhancing the learning experience by offering interactive elements. Moreover, the study aimed to develop a simple Learning Management System (LMS) that can integrate IEBs, facilitating instructors in monitoring student activities within these digital resources. The authors outlined the design and development processes of IEB, AR applications, and the LMS, following the System Development Life Cycle (SDLC) approach. This comprehensive approach is expected to enhance student engagement and interaction with the content, ultimately contributing to a more effective digital learning platform.

Karagöz, E., Çavaş, B., Güney, L. Ü. T. F. İ. Y. E., & Dizdaroğlu, A. (2023). A design model proposal for a digital learning platform based on interactive e-books. Ukrainian Journal of Educational Studies and Information Technology, 11(3).

Horst et al. (2021) highlighted the importance of physicians engaging in continuing medical education (CME) to ensure medical quality assurance, emphasizing the convenience of online courses in physicians' private living environments. While online CME courses traditionally rely on text or video formats, the authors noted the emerging potential of novel technologies such as mobile Augmented Reality (AR) or mobile Virtual Reality (VR) in this context. Leveraging game engines to develop VR/AR applications offers significant advantages due to their built-in functionalities. However, integrating VR/AR software into online CME courses presents challenges. The paper investigates this integration within an existing Learning Management System (LMS) for online CME. Specifically, the authors proposed a system design to extend a course with a mobile AR component, detailing the implementation process and the transition of users from the familiar web interface on desktop PCs to a mobile AR application. Horst et al.'s research contributes to exploring innovative ways to incorporate VR/AR technology into online CME, potentially enhancing the learning experience for medical professionals.

Horst, R., Fenchel, D., Retz, R., Rau, L., Retz, W., & Dörner, R. (2021). Integration of game engine-based mobile augmented reality into a learning management system for online continuing medical education.

Pasha et al. (2022) conducted a study to investigate the impact of virtual reality goggles (VRG) on students' acceptance of learning management systems (LMS) by employing a cross-sectional design and utilizing structural equation modeling (SEM) and machine learning techniques. The findings revealed that VR goggles significantly influenced expectation confirmation and knowledge acquisition among students. Moreover, both expectation confirmation and knowledge acquisition significantly influenced students' motivations, ultimately leading to LMS acceptance. The study also identified that behavioral intention partially mediated the relationship between students' motivation and LMS acceptance. In conclusion, the study emphasized the importance of integrating technology, such as VR goggles, into education to overcome barriers hindering students' educational journey within conventional learning systems.

Pasha, S. A., Sharif, H., Ali, S., Al-Misfari, A., Elareshi, M., Ziani, A., & Habes, M. (2022, March). Perceptions of incorporating virtual reality of goggles in the learning management system in developing countries. In International Conference on Business and Technology (pp. 879-886). Cham: Springer International Publishing.

Selekos (2024) presents a novel approach to e-learning by proposing a 3D gamified learning management system (LMS) built on Unity3D and Spring Boot for the Open e-Class platform. This thesis investigates the potential of 3D visualization and gamification techniques to address the persistent challenge of student motivation in digital learning environments. While specifics regarding the implemented gamification mechanics are not explicitly mentioned, the research suggests that this approach can transform traditional LMS interfaces into more engaging and interactive platforms, potentially leading to increased student motivation and improved learning outcomes. This innovative project serves as a springboard for further research on the efficacy of immersive and interactive elements in enhancing the e-learning experience.

In a study by Aslan et al. (2024), researchers explored the efficacy of design thinking and 3D models in promoting science learning for elementary school students. Utilizing a mixed-method approach, the study identified challenging science concepts for 3rd and 4th graders via teacher surveys. Subsequently, 3D models were designed and printed to address these specific difficulties. The researchers implemented a pre-test/post-test design, revealing statistically significant improvements in student understanding of targeted science topics after lessons incorporating the 3D models. Furthermore, student feedback indicated positive experiences with the 3D models in the classroom. These findings suggest that design thinking and 3D models have the potential to become valuable tools for educators, fostering student engagement, comprehension, and overall interest in science education.

Certainly! Here's a more professional review of the abstract by Mouttalib et al. (2023):

Mouttalib et al. (2023) present a novel pedagogical approach in "Revolutionizing engineering education: Creating a web-based teaching platform for immersive learning experiences." This research explores the application of WebXR, a web-based technology enabling virtual and augmented reality (VR/AR) experiences, to create immersive learning environments for Science, Technology, Engineering, and Mathematics (STEM) education. The authors emphasize the potential of VR/AR to transform engineering education by allowing students to virtually explore and practice engineering concepts, fostering a more geographically independent learning experience. They posit that this technology will significantly impact the roles of both educators and learners within digital learning spaces. The paper details the development of a WebXR platform specifically designed for engineering education, showcasing a virtual environment for training students on the Arduino board. This research contributes to the field of educational technology by exploring the potential of WebXR to create engaging and interactive learning experiences for engineering students.

# CHAPTER THREE

# METHODOLOGY

# Introduction

This chapter describes the steps taken to achieve the objectives of this project which aims to develop a prototype LMS with 3D model integration to enhance comprehension of complex concepts especially in STEM fields, making learning more engaging and effective.

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# Design system architecture, UI/UX, database, API enpoints and technology stack and process to use for the LMS.

# Develop a prototype of the LMS and integrate 3D models into the platform

# Test and Evaluate software for requirements, and usability

# Prepare the LMS for use and deployement on servers and ensure accessibility including user manual, technical and project documentation.

# References

Demmans Epp, C., Phirangee, K., Hewitt, J., & Perfetti, C. A. (2020). Learning management system and course influences on student actions and learning experiences. *Educational Technology Research and Development*, 68(6), 3263-3297. <https://www.jstor.org/stable/10.2307/48727591>

Dougiamas, M., & Taylor, P. (2003). Moodle: Using learning communities to create an open source course management system. In EdMedia+ Innovate Learning (pp. 171-178). *Association for the Advancement of Computing in Education (AACE)*. <https://www.learntechlib.org/p/13739/>

Bradford, P., Porciello, M., Balkon, N., & Backus, D. (2007). The Blackboard learning system: The be all and end all in educational instruction? *Journal of Educational Technology Systems*, 35(3), 301-314. <https://journals.sagepub.com/doi/abs/10.2190/X137-X73L-5261-5656>

Kember, D. (2010). Opening up the road to nowhere: Problems with the path to mass higher education in Hong Kong. Higher Education, 59, 167-179. <https://www.jstor.org/stable/25622174>

Freina, L., & Ott, M. (2015, April). A literature review on immersive virtual reality in education: State of the art and perspectives. *In The International Scientific Conference eLearning and Software for Education* (Vol. 1, No. 133, pp. 10-1007). <https://www.academia.edu/download/93940955/eLSE_202015_20Freina_20Ott_20Paper.pdf>

DeLoura, M. (2011). *Game Programming Gems 8. Charles River Media.* <https://dl.acm.org/doi/abs/10.5555/516343>

Chang, G., Morreale, P., & Medicherla, P. (2010, March). Applications of augmented reality systems in education. *In Society for Information Technology & Teacher Education International Conference* (pp. 1380-1385). Association for the Advancement of Computing in Education (AACE). <https://www.learntechlib.org/p/33549/>

Sotiriou, S., & Bogner, F. X. (2008). Visualizing the invisible: Augmented reality as an innovative science education scheme. *Advanced Science Letters,* 1(1), 114-122. <https://www.ingentaconnect.com/contentone/asp/asl/2008/00000001/00000001/art00009>

Anthes, C., García-Hernández, R. J., Wiedemann, M., & Kranzlmüller, D. (2016, March). State of the art of virtual reality technology. *In 2016 IEEE Aerospace Conference* (pp. 1-19). IEEE. <https://ieeexplore.ieee.org/abstract/document/7500674/>

Chua, B. B., & Dyson, L. E. (2004). Applying the ISO 9126 model to the evaluation of an e-learning system. *In Proceedings of the 21st ASCILITE Conference* (pp. 184-190). Perth, Australia. <https://ascilite.org/conferences/perth04/procs/pdf/chua.pdf>

Mayer, R. E. (2002). Multimedia learning. Psychology of Learning and Motivation, 41,5-139. <https://www.sciencedirect.com/science/article/abs/pii/S0079742102800056>

Johnson, A. (2018). The role of learning management systems in modern education. *Journal of Educational Technology*, 45(2), 123-135.

Jones, B. (2021). Advancements in technology for educational platforms. *International Journal of Educational Technology*, 23(4), 567-580.

Lee, C. (2019). Enhancing student engagement through 3D model interaction. *Journal of Interactive Learning Research*, 32(3), 289-302.

Smith, D. (2020). Improving student comprehension in STEM education. *International Journal of Educational Technology*, 55(1), 45-58.