



A VIRTUAL REALITY-ENHANCED LEARNING SYSTEM FOR LOCAL EDUCATION IN VIETNAM: DESIGN AND EVALUATION

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ABSTRACT

Aim/Purpose	This study designs and implements a virtual reality (VR)-enhanced learning system accessible via web and mobile platforms. The system aims to support and improve the teaching and learning of the Local Education (LE) subject, specifically targeting Grade 10 students in Lamdong province, Vietnam.
Background	LE is a new subject that has recently been added to the K-12 curriculum in Vietnam to provide the students with regional identity, cultural awareness, and understanding of local geography. However, the subject lacks interactive learning materials and sufficient teaching experience among teachers, leading to passive teaching methods. To address these issues, this study explores how advanced technologies can be leveraged to enrich teaching and learning experiences for LE.
Methodology	We developed a technology-enhanced learning system comprising VR, web, and mobile components that feature 360-degree tours of local landmarks, cultural videos, interactive quizzes, and self-assessment tools. The system was evaluated based on surveys with more than 7,700 participants, involving teachers and Grade 10 students. Quantitative analysis was conducted to assess engagement and user perceptions.

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Contribution	This study presents one of the first large-scale implementations of educational technology for the LE subject in Vietnam, particularly in Lamdong province. First, we provide a platform for LE's content presentation using VR technology and mobile/web applications. Next, various content related to the LE subject is presented in different ways to support and engage students in their studies. Lastly, the positive efficiency of the proposed platform is proven empirically when deploying to high schools in Lamdong province.
Findings	After using the proposed learning system, most students found that the new approach made studying the LE subject more interesting and relevant. Through the VR-based activities, the students better understood local culture, history, and geography. Moreover, the teachers reported improvements in instructional confidence, flexibility, and student participation. The teachers expressed willingness to continue using and extending the system to other grades and subjects.
Recommendations for Practitioners	The integration of the latest technologies, e.g., VR and web/mobile applications, into the LE subject can boost students' learning motivation. To teach the subject efficiently, the teachers should be trained for digital content curation and interactive lesson design.
Recommendations for Researchers	The researchers can investigate the impacts of the latest technologies on LE subject and learning outcomes. The effectiveness of the new learning system across different provinces in Vietnam should also be investigated.
Impact on Society	LE subject is important in connecting the students with their cultural, historical, and geographic heritage. The proposed learning system contributes to preserving regional identity and providing a model for the digital transformation of public education in Vietnam.
Future Research	The proposed learning system will be expanded to other subjects, such as History or Literature. Moreover, the system should be expanded and evaluated not only in Lamdong province, but also in other provinces in Vietnam.
Keywords	local education, technology-enhanced learning, virtual reality, web/mobile applications, high school education

INTRODUCTION

Local education (LE) has received significant attention worldwide because it focuses on local culture, history, and geography. The materials used for the subject follow an open and flexible approach while remaining stuck to content related to the local socio-economic and cultural context. Even though the name of the subject may differ depending on the country, the main idea of the subject is not only to provide the basic knowledge about one specific province but also to provide practical experiences related to regional values, creating opportunities for students to engage in meaningful and effective learning (Squires, 2013).

In Vietnam, LE has been considered a formal subject in the K-12 curriculum since 2018, as noted in the new General Education Program (Kieu et al., 2024; Trung, 2023). The content used in the subject is closely connected to the local economic, political, labor, production, and cultural context. However, it has been integrated into the curriculum for all grade levels since the 2022-2023 academic year. Thus, although the content of LE is meaningful, its implementation is still relatively new. Further research and improvement are necessary in both content and teaching methods, as well as in assessment and evaluation, to achieve the desired effectiveness. The subject not only helps students gain a deeper understanding of their homeland but also increases awareness and responsibility in preserving

and promoting local traditional values. Although the subject can help students explore and understand their province's cultural identity, traditions, and geography, many schools currently face difficulties delivering LE content effectively due to limited resources, outdated materials, and a lack of student interest.

In Lamdong province, the LE curriculum includes five topics related to history, geography, culture, economy, and environment, with a total of 35 periods per year. Teachers from various subject departments are assigned to deliver the lessons. Additionally, the mid-term and final exams are conducted twice per year using either paper-based or computer-based methods. The implementation of the LE subject is supported by favorable conditions. Lamdong is a province in the Central Highlands of Vietnam. Currently, Lamdong is home to diverse ethnic communities, including over 40 groups, which offer colorful educational content reflecting unique local cultural, historical, economic, and social characteristics (Diem & Thien, 2020). These local characteristics not only enhance the authenticity of learning experiences but also align with national goals of improving regional identity and civic engagement through education. However, to enhance the quality of the LE subject when implemented across high schools in Lamdong province, there are still difficulties in teaching and learning the LE content. In the context of LE, traditional teaching is generally characterized by teacher-centered, lecture-based instruction that relies primarily on printed textbooks and oral explanations, with limited use of multimedia or interactive learning activities. By contrast, technology-enhanced teaching refers to the integration of digital learning approaches, e.g., multimedia learning resources, interactive visual content, etc., to support interactive, experiential, and student-centered approaches to teaching and learning LE content.

In recent years, the applications of Information and Communication Technology (ICT) have been widespread in different fields such as healthcare, agriculture, and transportation, to support the improvement of these fields and enhance human comfort. Particularly, ICT has become increasingly common in education (Haldorai et al., 2021; Mielikäinen, 2022). The latest technologies, such as virtual reality (VR) or augmented reality, offer students more interactive and interesting learning experiences, especially in subjects that are related to local cultural, historical, or geographical content.

The utilization of ICT can enhance the quality of education (Msafiri et al., 2023; Ngao et al., 2022). The students' learning activities, such as exploration, practice, and application of problems, can be supported by teaching equipment, especially digital tools and automated systems enabled by modern technologies. However, in many countries, especially developing countries, the application of ICT in education remains at a basic level, typically limited to presenting text, images, charts, videos, etc. For the LE subject, which involves practical and local content, the lack of ICT applications will diminish students' interest in self-study and independent exploration. Thus, researching advanced ICT applications to diversify teaching methods for LE content has become an essential issue, helping to make learning more engaging and effective. In addition, the building of a digital learning materials repository related to the LE subject is also crucial since it directly affects the success of the subject's implementation. Thus, the repository should not only involve basic images or videos, but should include VR-based products such as 360-degree VR, which enables teachers and students to interact with objects by rotating, adjusting, resizing, and analyzing individual components such as a historical site, a traditional musical instrument, a vegetable greenhouse, a brocade costume, etc.

Although it has been recognized that the LE subject strongly supports the students' understanding of regional culture, history, geography, and socio-economic characteristics, its implementation in Vietnamese high schools, particularly in Lamdong province, remains challenging due to traditional lecture-based teaching methods, limited multimedia resources, and a lack of experiential learning. Recent advances in ICT offer promising opportunities to enhance engagement and learning effectiveness. However, empirical evidence on the large-scale integration of immersive technologies into the LE subject is still limited. To address this gap, this study investigates the design and application of a VR-enhanced learning system integrated with web and mobile platforms for the LE subject, especially focusing on Grade 10 students in high schools in Lamdong province. Differing from existing

ICT-based educational approaches, we focus on curriculum-aligned, locally contextualized LE content and validate the proposed system through large-scale implementation in real high school classrooms. Through this study, we address the following research questions: (1) how to design an immersive VR-enhanced learning system for the LE subject; (2) whether the system improves student engagement and learning outcomes compared to traditional methods; and (3) how teachers and students perceive its usability and pedagogical effectiveness. The major contributions are as follows.

- A VR-enhanced learning platform is introduced with web/mobile applications to simulate real-life local educational experiences. The system involves various functions, including 360-degree virtual tours, multimedia content, online self-learning, and self-assessment tools.
- A digital learning materials repository related to topics in the LE curriculum is being built, which involves various types of materials, such as texts, images, audio, videos, and 360-degree VR scenes, all related to the LE subject.
- To evaluate the pedagogical effectiveness of the system on the LE subject, the system was implemented in several Grade 10 classes in high schools across Lamdong province, involving over 7,700 participants. The survey's results show a significant improvement in student engagement and understanding compared to traditional learning methods.

The remaining part of this paper is organized as follows. The related work section presents a review of relevant prior studies. Then, the next section outlines the system design, followed by the empirical results and data analysis section. Finally, the last section summarizes the key conclusions and proposes directions for future research.

RELATED WORK

STUDIES ON LE IN VIETNAM

In Vietnam, there is still a lack of extensive research on the LE subject. Thong and De (2022) aimed to develop effective learning systems for students, particularly elementary school students. They highlighted the essential resources required for effective implementation of educational models, including multimedia equipment, video content, group activity tools, and practical materials related to local history and geography. Even though this was a reasonable requirement, it became a challenge for schools that face difficulties in terms of infrastructure or lack technological updates. For elementary school students, a blended learning system, i.e., combining face-to-face and online instruction, was proposed, which emphasized the application of ICT in education (De & Nghia, 2020). However, the implementation remains at a basic level, limiting students' learning and interaction. Ha (2021) investigated the current implementation of LE content in boarding high schools, focusing on educational content, teaching methods, and forms of instructional organization. The author concluded that the key issues that need to be addressed in the implementation of LE content include teaching methods, instructional organization, infrastructure, and teaching equipment.

INTERNATIONAL STUDIES ON LE

While LE subject in Vietnam has only received significant attention since 2018, the concept and orientation of local education have long been a focus in curricula around the world. In Indonesia, the subject was an essential and integral part of the national education curriculum, with learning activities implemented at both primary and secondary education levels (Suratno, 2012). Meanwhile, in China, the LE content was delegated to each individual province, which was responsible for developing, managing, and implementing its own education program (Chan & Wang, 2009). From various studies (Bulut & Bars, 2013; Prastiwi, 2013; Strouse & Nickerson, 2016), LE subject was proven to help students understand the values of their homeland or the characteristics of their region. This would improve students' love for the places where they live through learning activities and experiences. Learn-

ing, therefore, is not limited to the acquisition of knowledge but also involves experiencing the practical values of the local region, thereby providing students with meaningful and relevant learning opportunities.

DIGITAL AND IMMERSIVE TECHNOLOGIES IN EDUCATION

Considering the application of ICT to enhance teaching quality, numerous studies have explored the mobile learning model (Farley & Song, 2019), in which students were encouraged to bring their own mobile devices to support learning tasks. Moreover, the cloud-based classrooms and connected classroom environments have also gained increasing attention and implementation (MacLeod et al., 2018). The integration of VR in education has gained increasing attention in recent years, which allows students to engage in immersive virtual or simulated environments that closely mimic real-life experiences.

In Makransky and Mayer (2022), and Velez and Zlateva (2017), the benefits of VR in education were discussed, including inspiring creativity, increasing motivation, and promoting social inclusion. Activities that are difficult or impossible to conduct in physical spaces can be effectively designed and delivered in virtual environments. Zhao et al. (2025) provided design recommendations for heritage-based VR experiences in secondary schools, emphasizing the importance of spatial immersion and interactive elements. For the LE subject, several studies have explored the use of ICT, e.g., digital platforms, to teach culturally relevant content. Rizvić et al. (2019) developed a VR platform for high school classrooms centered on storytelling, highlighting narrative immersion and the collaborative construction of meaning in digital heritage experiences. Furthermore, Anwar et al. (2025) discussed the potential of extended reality in cultural heritage learning, while Bekas and Xinogalos (2024) proposed a location-based augmented reality mobile application to guide students through historical monuments, showing improvements in historical thinking.

It can be observed that research on the LE subject remains relatively limited, especially in developing countries. While existing studies consistently highlight the importance of LE within the new General Education Program, they also point to ongoing difficulties in its effective implementation. Previous research has shown that digital learning approaches can enhance student engagement and instructional flexibility. However, these benefits are often discussed in broad terms, with limited focus on subject-specific contexts such as LE. Among these approaches, VR has demonstrated strong potential for experiential and context-rich learning, which supports learners to explore content in immersive environments. This highlights the urgent need for further research to examine how such technologies can be effectively applied to LE. Our study aims to bridge this gap by developing and evaluating a VR-enhanced web/mobile system, focusing on the LE content for Grade 10 students in Lamdong province. Unlike prior works, this study combines technology development with empirical evaluation involving over 7,700 teachers and students, providing both design insights and measurable evidence of pedagogical impact.

SYSTEM DESIGN

OVERALL SYSTEM ARCHITECTURE

The proposed learning system aims to enhance the teaching and learning experiences for the LE subject. The system is designed following a modular, service-oriented architecture that enables flexibility, scalability, and cross-platform compatibility. The system architecture is shown in Figure 1, comprising three major components: a web-based frontend for student and teacher interaction; a mobile application for immersive, portable access; and a backend system that manages data, authentication, and content delivery. The system supports smooth integration among various user devices and learning experiences through the use of a RESTful Application Programming Interface (API) and a centralized Structured Query Language (SQL) server database.

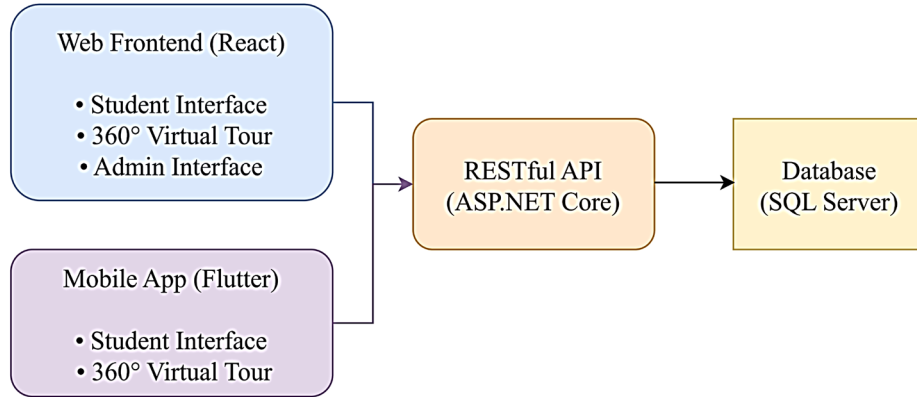


Figure 1. System architecture

SYSTEM COMPONENTS AND FUNCTIONALITIES

Web frontend

The web application is built using React.js (Fedosejev, 2015), which is a modern JavaScript framework known for its responsiveness, component-based structure, and scalability. The integrated learning content within the web application is carefully selected to align closely with the LE subject. It incorporates a variety of multimedia elements, including videos, audio guides, explanatory texts, and other materials that complement the virtual scenes. The web supports two main user roles: students and teachers/admins. For the student interface, some major features are proposed as follows.

- *Lesson Access Interface:* Students can search and access available VR-based LE modules.
- *360° Virtual Tours:* Using the Panolens.js library (Boukerch et al., 2021), students can explore local landmarks and heritage sites in immersive and spherical views. This supports the students to understand the local culture, history, and geography more easily and interactively.
- *Self-assessment Modules:* To assess the knowledge acquired from the LE content, multiple-choice quizzes and reflection questions are integrated into each learning module, and students must complete quizzes in each module to progress to the next. Within the proposed system, self-assessment activities serve formative purposes, which allow students to check their understanding of LE content and receive immediate feedback. These activities support learning and classroom discussion, while formal assessment remains the responsibility of teachers.

Moreover, for the teachers/admins interface, the main features are as follows.

- *Content Management System:* Teachers/admins can upload, edit, and organize VR scenes, quizzes, and content such as texts, audios, videos, etc.
- *Student Monitoring Tools:* Teachers/admins can access usage statistics, quiz results, and progress analytics.
- *User Role Management:* Teachers/admins can make the creation and assignment of student accounts, with the ability to group by class or school.

The web application of the learning platform is available at <https://gddplamdong.dlu.edu.vn/>. The website includes access to 360° virtual scenes, LE content, interactive quizzes, and so forth. Figure 2 shows the homepage of the website for the student when they connect to the aforementioned link, followed by a brief introduction to the website, which is displayed in Figure 3.



Figure 2. The homepage of the website

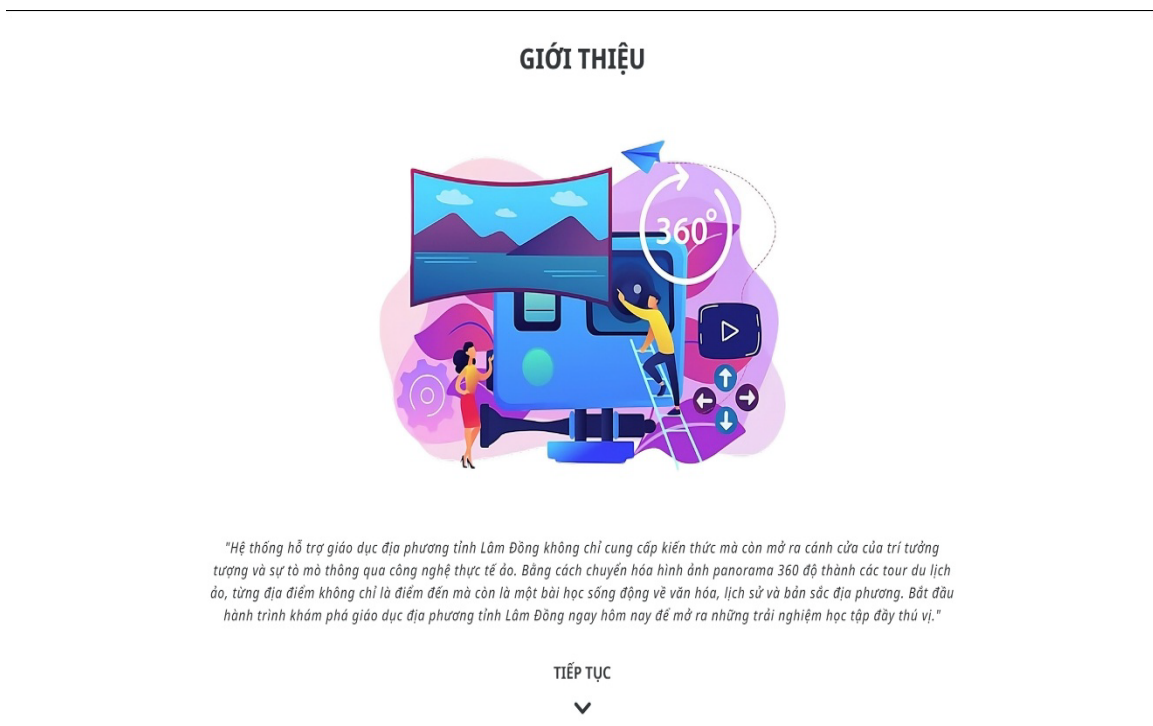


Figure 3. The brief introduction to the website

Details of the course content are shown in Figure 4 with the list of modules. In addition, the interface of the 360-degree tour is displayed in Figure 5. It is worth noting that the VR modules are designed in close alignment with the five topics in the Grade 10 LE curriculum and target three key learning outcomes. These include students' awareness of local cultural, historical, and geographical contexts, the development of analytical and application skills, and increased engagement with LE content. This alignment is realized through the design of learning tasks, formative assessments, and student feedback, which ensure that VR integration directly supports curricular goals.

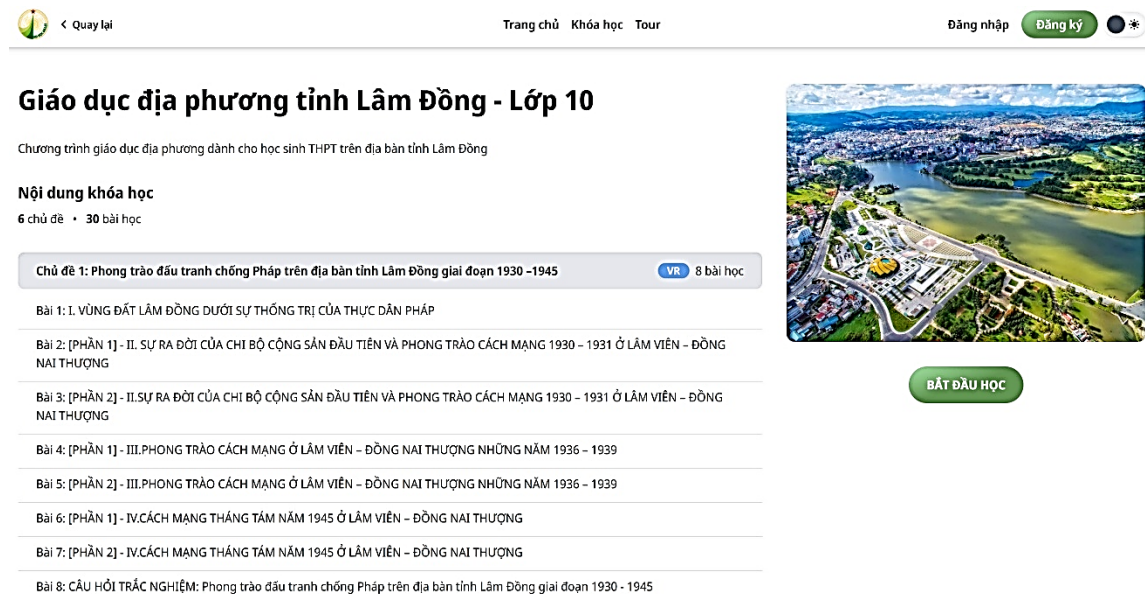


Figure 4. The course content on the website



Figure 5. 360-degree VR tour

Mobile application

To make learning the Local Education subject more comfortable and accessible for students, we developed a cross-platform mobile application using Flutter (Windmill, 2020), a development framework provided by Google that allows the same application to run smoothly on mobile devices, web browsers, and desktop computers. The mobile application is built using Flutter to support both Android and iOS devices. In this application, the main users will be the students, with some major features as follows.

- *VR Compatibility*: VR modules are integrated into the application in a way that allows students to view LE content in immersive, three-dimensional scenes. When used with VR headsets, these modules provide a more realistic and engaging learning experience.

- *Interactive Learning Paths*: Students can follow the instructional guides and module-specific tasks to navigate through multiple modules, helping students clearly track and reflect on their learning path.

The login and registration interfaces of the mobile application are shown in Figure 6. Meanwhile, from left to right in Figure 7, the homepage, course page, and tour page interfaces of the mobile application are illustrated. The mobile application is available for download at the following link: https://github.com/DalatCoder/GDDP_LamDong2025.

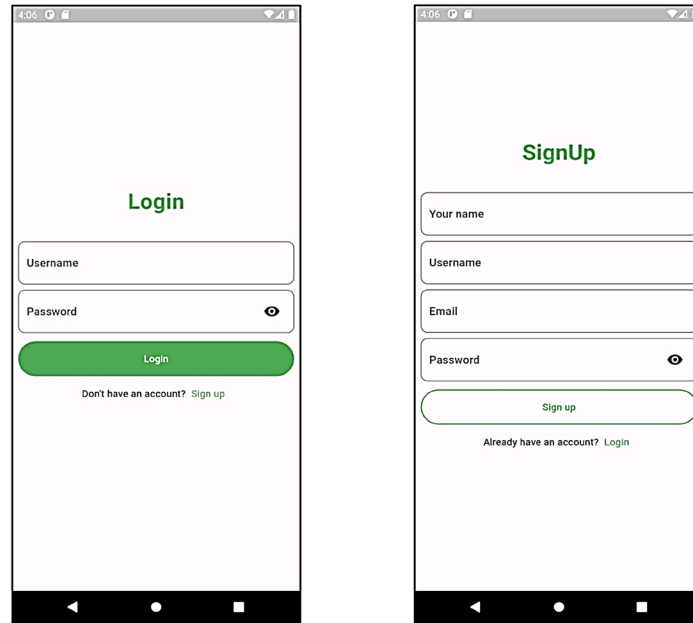


Figure 6. Login and registration interfaces of the mobile application

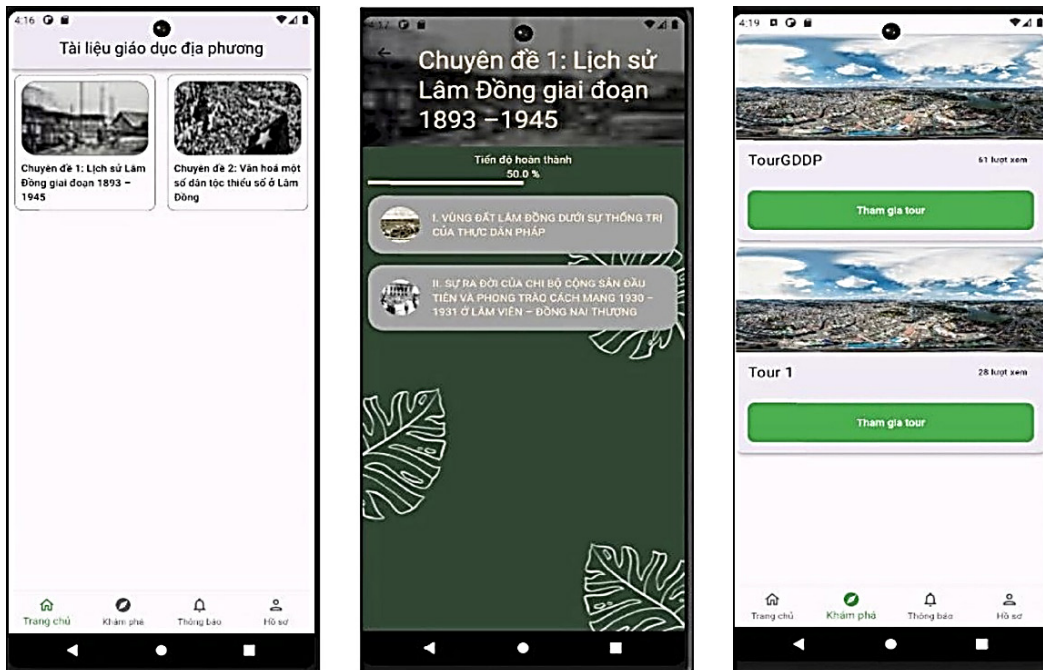


Figure 7. Homepage, course page, and tour page interfaces of the mobile application

Database

The database is hosted on Microsoft SQL Server and is used to store all persistent user data, content metadata, and usage logs. To be more specific, the learning system's database includes: (1) the user information (students, teachers, schools), (2) LE content metadata, (3) quizbanks and correct answer mappings, (4) usage logs, scores, and student progression data, and (5) multimedia metadata for VR scenes and integrated files. It is worth noting that the system stores information in a well-organized way to ensure accuracy and reliable access. In addition, sensitive user information, such as login details, is protected using secure methods to safeguard privacy.

RESTful API

The backend API is built using ASP.NET Core (Lock, 2023), which is a high-performance, cross-platform framework developed by Microsoft. This RESTful API plays a role as the connection between the frontend/mobile clients and the server-side database. The system architecture with RESTful API is presented in Figure 8. This architecture enables the development of flexible, easily integrated, and scalable APIs. RESTful API is used to manage user login and access control through secure authentication mechanisms, including JavaScript Object Notation (JSON) Web Tokens and role-based permissions, which ensure that users can only access functions appropriate to their roles. Next, it also manages essential information, such as LE materials, user profiles, learning progress, and quiz results. In addition, it can also be used to record user interaction data, such as engagement time with VR content, quiz attempts, and device usage, to support usage analysis. The data are analyzed to provide recommendations for further improvement. At last, the system is built to maintain smooth performance when used by a large number of users simultaneously.

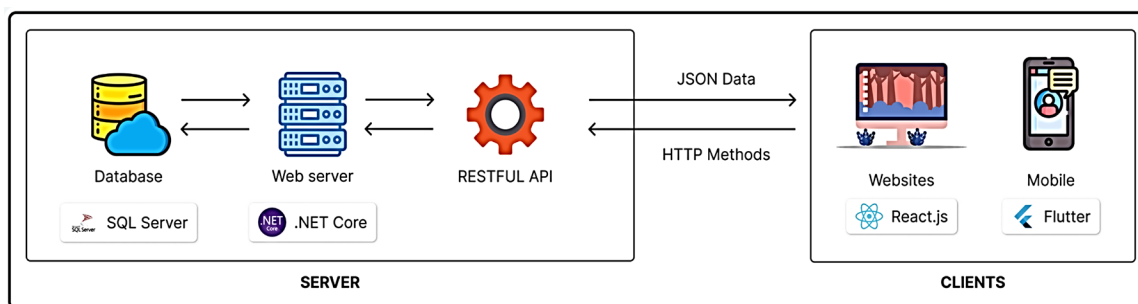


Figure 8. System architecture using RESTful API

CLASSROOM-USE SCENARIO

To illustrate how the proposed system can be integrated into real classroom practice, we present a typical 45-minute LE lesson conducted for Grade 10 students in Lamdong province. The lesson topic focuses on the local history of Lamdong province during the resistance period (1930–1945) and follows the standard four-phase instructional structure: warm-up, knowledge formation, practice, and application.

In the warm-up phase, the teacher introduces the topic by showing a short video to the students about Lamdong during the French colonial period to bring interest and remind them of prior knowledge, as illustrated in Figure 9. During the next phase, knowledge formation, VR scenes are combined with maps and images to support the explanation of key historical events. Students not only observe but also respond to guiding questions. In the practice phase, students work in small groups to analyze assigned VR contexts, which identify historical background, events, and significance. Finally, in the last phase, application, students reflect on the historical value of selected sites and discuss preservation measures, with optional follow-up assignments such as creating short explanatory videos or written VR-based guides.



Figure 9. Example video for teaching a historical lesson in the LE subject

Differing from existing VR-based systems that focus on standalone immersive experiences or small-scale pilot implementations, the proposed system is designed as a complete learning environment that matches the LE curriculum. It integrates VR content with structured learning tasks, formative assessments, and classroom-use scenarios, and is suitable for deployment in multiple schools. Nonetheless, it should be pointed out that although the proposed system provides several advantages to the LE subject, its real-world deployment can be affected by various factors, e.g., uneven school infrastructure, varying levels of teachers' familiarity with digital tools, and time constraints in the classroom. These considerations highlight the need for sufficient teacher support and flexible adaptation to local teaching conditions.

EMPIRICAL RESULTS AND DATA ANALYSIS

LE SUBJECT FOR GRADE 10 IN LAMDONG PROVINCE

In Lamdong province, the LE subject has been implemented in the K-12 curriculum since the 2024-2025 academic year, with Grade 1, Grade 6, and Grade 10 representing the elementary, middle, and high school levels, respectively. It provides students with meaningful knowledge and engaging learning experiences, helping them build a strong connection with their homeland, which is suitable for the objectives of the 2018 General Education Program.

In this work, we implement the VR-enhanced learning system for the Grade 10 students, as they are the first high school group to study the LE subject. Moreover, they are expected to have enough experience to work and study with modern technologies, particularly ICT-based tools. The Grade 10 LE content in Lamdong province is designed with a total of 35 periods, each with 45 minutes. The content covers five main modules as follows:

- *Module 1:* The anti-French resistance movement in Lamdong province during the period 1930-1945.
- *Module 2:* The culture of some ethnic minorities in Lamdong province.
- *Module 3:* Folk literature in Lamdong province.
- *Module 4:* Production activities in agriculture, forestry, aquaculture, and industry in Lamdong province.
- *Module 5:* Urbanization and its impact on the socio-economic and environmental development of Lamdong province.

RESEARCH METHODOLOGY

This study used a design-based research approach combined with a quasi-experimental pre-test and post-test design using mixed methods. This research design is appropriate for developing and evaluating educational interventions in real classroom settings. The study involved assessing the current implementation of the LE subject, deploying a VR-enhanced learning system, and evaluating its pedagogical impact through comparative pre- and post-intervention data collected from both teachers and students.

The data collection process was divided into two phases. The first phase involved surveying the current state of teaching and learning the LE subject, i.e., pre-intervention survey, which was conducted in the middle of the first semester of the 2024-2025 academic year (October), after the students had completed the first two LE modules using traditional teaching methods. Then, the second phase took place in the middle of the second semester (April), i.e., post-intervention survey, after the students had completed the remaining three LE modules with the support of the new VR-enhanced learning system. This allows for a comparative analysis of the proposed system's effectiveness before and after the deployment.

Data were collected through pre- and post-intervention questionnaires completed by both teachers and students participating in the study. The survey instruments were self-developed by the authors based on the objectives of the Grade 10 LE curriculum and the functional features of the proposed learning system. The questionnaires focused on key dimensions, including students' learning interest, engagement, and perceived understanding of LE content, as well as teachers' perceptions of system usability and instructional support. Example questions included "The learning activities help me better understand LE content" or "The system increases students' engagement during lessons."

In the pre-intervention survey, 474 teachers and 7,269 students from various high schools in Lamdong province participated in the process. The survey aimed to capture the current status of the LE subject when implemented to teachers and Grade 10 students, including teaching strategies, teaching materials, infrastructural support, and engagement with the subject.

Following the initial assessment, the intervention was carried out by introducing the VR-enhanced learning system, deployed on both web and mobile applications. To ensure usability, teacher training sessions and student orientation programs were organized to help users better understand the system's core functions.

After a period of system use, the post-intervention survey was conducted with the same teachers and students who were involved in the previous survey. This phase focused on evaluating user experience, system usefulness, system usability, pedagogical impact, and engagement outcomes.

BEFORE USING THE LEARNING SYSTEM

In the pre-intervention survey, the crucial role of the LE subject within the 2018 General Education Program is highly recognized among teachers, reflecting a positive view of the subject's role, with over 89% of teachers rating it as either "important", i.e., 68.6%, or "very important", i.e., 21.3%. These results indicate that most teachers view the LE subject as a key component in improving students' understanding of local culture, history, and geography, which are essential to shaping responsible citizens with a strong connection to their community. On the student side, overall, 80.4% of the students rated the LE content either "very attractive" or "attractive", which confirms a strong interest in learning aspects related to their homeland. However, while 26% of students described the content as "very attractive", only 7% of teachers agreed with this point, which shows a disconnect between how the subject is perceived and how it is delivered.

The survey's results also illustrate the key differences between teacher-reported and student-experienced teaching methods, as shown in Figure 10. From the figure, group discussion was claimed as

the primary teaching method by 69.8% of the teachers, but only 42.1% of the students confirmed experiencing this method. In contrast, 52.4% of the students answered that lecturing was the most effective method for teaching the LE subject, whereas the percentage of teachers who preferred this method is 10% lower. This difference suggests that while teachers may want to use interactive methods, the students are still stuck with the traditional ones. Moreover, both groups agreed that problem-based learning, game-based activities, and Q&A methods were used less frequently, reflecting a big challenge in implementing suitable teaching methods for LE content. Thus, there is an emerging demand for a more effective, resource-rich, and technology-integrated method to teach the LE subject.

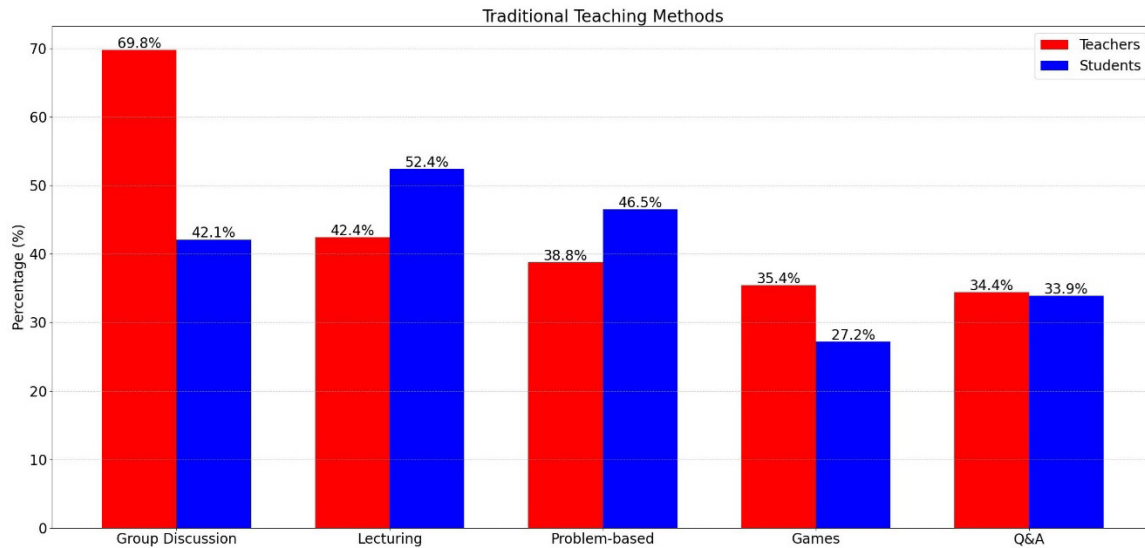


Figure 10. Differences between teachers and students in teaching methods

Considering teaching infrastructure and learning materials, the analysis reveals significant limitations. Even though most schools are currently equipped with basic teaching facilities, such as classrooms and projectors, the availability of digital resources remains limited. Moreover, the teachers also reported a shortage of multimedia content specifically designed for the LE subject, such as interactive videos, audio recordings, and VR materials. These constraints not only limit the effective delivery of LE content but also reduce opportunities for students to explore local knowledge beyond textbooks and classroom lectures.

AFTER USING THE LEARNING SYSTEM

After the implementation of the VR-enhanced learning system on web/mobile applications, a comprehensive post-intervention survey was conducted to evaluate its effectiveness in supporting the teaching and learning of the LE subject for Grade 10 students in Lamdong province.

About the usability, most users from both groups confirmed that the learning system was accessible and easy to use. For teachers, 90.7% evaluated the system as either easy to use or manageable in its navigation and interface. This is a promising indicator, especially given the diverse levels of digital literacy among teachers. Moreover, these results also prove that the training process provided before the system operation is effective. Meanwhile, the students also shared a similarly positive view, with 93.5% of them reporting that the learning system was easy to use. The results from both groups indicate that the interface and system design sufficiently support users, including those with limited technical backgrounds.

Next, regarding the system's impact on teaching effectiveness, the result shows that the system helps teachers to prepare more dynamic and visually enriched lesson plans, as agreed by 78.1% of teachers.

This point is important for the LE subject since it often suffers from abstract or text-heavy content. The new VR-enhanced learning system is built with multimedia components, e.g., images, audio, videos, and VR content, which allows for greater variation in lesson formats and delivery, instead of depending on traditional teaching methods. Furthermore, it is reported that 46.9% of teachers agreed that the system helped them save time in lesson preparation since they could utilize the collected materials to make their lessons. In addition, 47.1% of teachers also observed improved student engagement in class as a result of using the system.

Considering the impact of the system when implementing the modern teaching methods, the results can be seen in Figure 11. From the figure, 55.9% of teachers agreed that the system enhanced visual-based teaching, followed by group discussions and experiential learning methods. These are central to the goals of the 2018 General Education Program, which emphasizes competence development, active learning, and the connection of school knowledge to real-life contexts. Therefore, the VR-based learning system is not only a content delivery platform but also a pedagogical tool to support various teaching methods.

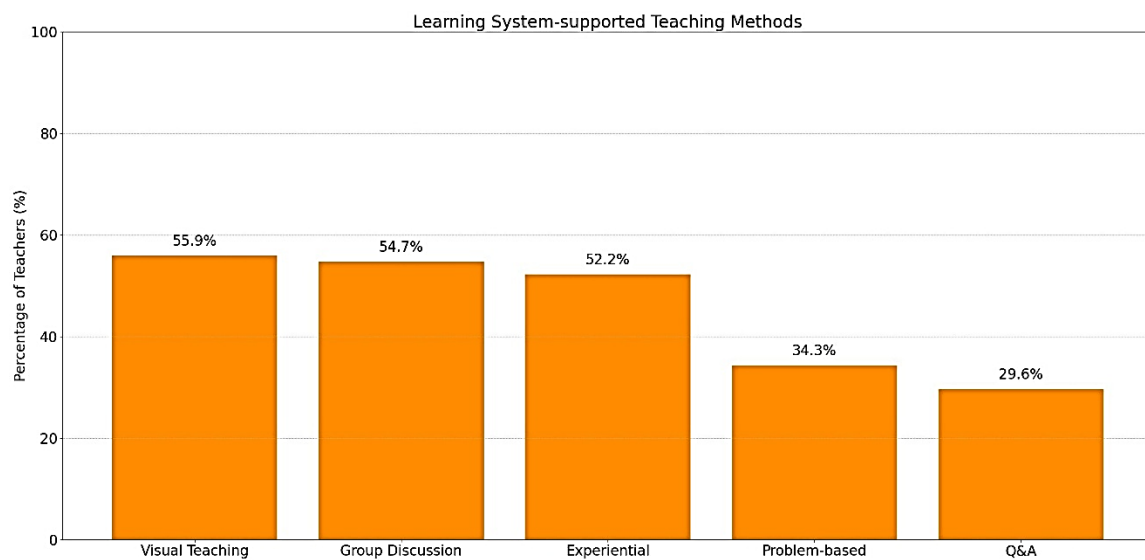


Figure 11. The impact of the learning system on teaching methods

Lastly, regarding student learning outcomes, as shown in Figure 12, 92.2% of students reported that using the proposed learning system helped them better understand the LE content. This is a remarkable improvement in content accessibility and conceptual understanding, resulting from the system’s integration of visual and interactive components that are suitable for diverse learning preferences. In addition, 89.1% of students felt that they were more engaged while learning through the system compared to conventional teaching methods. This confirms that the integration of ICT with digital tools has great potential when implemented in education.

The empirical results reveal clear and measurable gains in students’ learning interest, engagement, and perceived understanding, effectively addressing the main challenges of the LE subject, such as limited learning resources and the lack of meaningful, experience-based learning. Moreover, teachers’ positive ratings of system usefulness further indicate support for interdisciplinary teaching. Overall, the post-intervention evaluation demonstrates the effectiveness of the VR-based learning system in enhancing both teaching and learning experiences in the LE subject. High usability, strong support for pedagogical objectives, and clear improvements in student understanding and engagement were consistently reported by both teachers and students. These findings support the continued use and potential expansion of the system to other subjects and provinces.

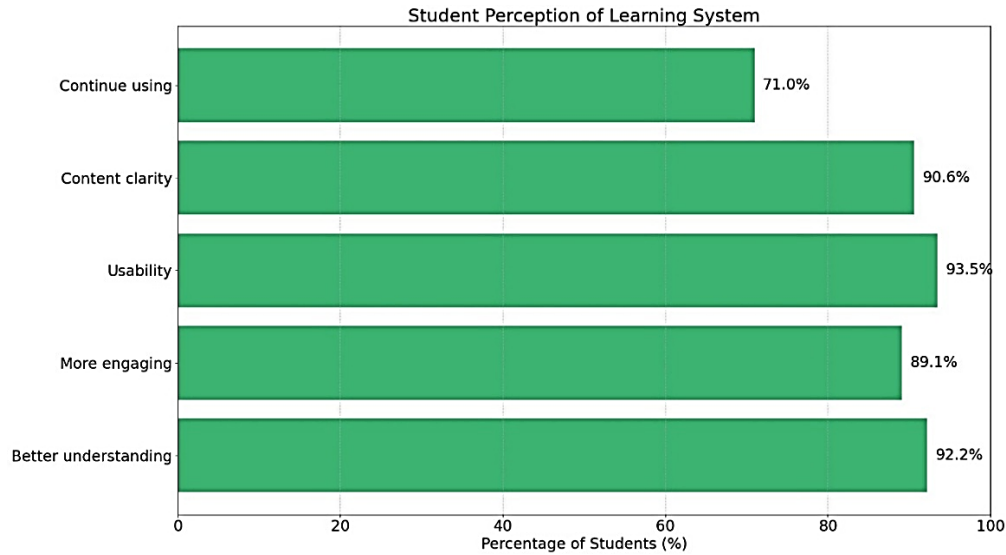


Figure 12. The student perception of the VR-enhanced learning system

It is essential to note that the findings of this study primarily rely on self-reported feedback from teachers and students. Thus, the findings may be influenced by certain biases. Since the study uses a design–implementation–evaluation approach, the results may reflect participants’ subjective perceptions as well as technology-related effects. These factors should be considered when interpreting the findings. Future research could provide stronger evidence by using more objective measures and conducting longer-term evaluations in a broader range of educational contexts.

USER FEEDBACK AND SUGGESTIONS FOR IMPROVEMENT

Based on qualitative feedback from both teachers and students after using the VR-enhanced learning system, the strengths and limitations of the system are discussed for further improvement. Even though most teachers agreed that the system’s interface was easy to use, 10% found that the interface was complex and difficult to use. They suggested the need for a more intuitive and streamlined design. Besides the interface concerns, 5.9% of teachers felt that the content did not adequately meet their teaching needs or reflect the regional characteristics of their students. This feedback indicates a demand for more localized and adaptable materials within the proposed learning system. In addition, many teachers recommended incorporating a wider variety of resources, including region-specific case studies, district-specific lesson templates, and updated quizzes to enhance assessment practices. More than 70% of teachers expressed their willingness to continue using the new learning system, provided that it is improved based on their suggestions.

For students, a notable limitation was the lack of engaging features, as approximately 8% described the material as unattractive or dull, even though the system included many images and videos. Moreover, some of them suggested a more user-centered design for the system’s interface, as revealed by teachers. To improve the learning experience, students requested more interactive features, such as educational games, scenario-based simulations, and quizzes that provide instant feedback. Many students also requested personalized learning paths that adjust to their pace and understanding level, along with features such as integrated chatbots to answer questions during self-study. The feedback points out a shared priority among teachers and students: a system that is not only functional but also flexible, engaging, and accessible. Addressing these issues would significantly enhance the system’s effectiveness and sustainability. Table 1 summarizes the challenges as well as suggestions for improvements from both groups.

Table 1. Challenges and suggested improvements for the VR-enhanced learning system

User group	Challenges	Suggestions
Teachers	Interface difficult to navigate.	Simplify interface design.
	Content not meet teaching needs.	Add localized content and district-specific materials.
	Limited variety of teaching resources.	Provide ready-to-use templates, updated lesson plans, and diverse multimedia.
	Lack of interactive or assessment tools.	Include quizzes with automated feedback.
Students	Content not engaging enough.	Enrich lessons with storytelling, gamification, and scenario-based simulations.
	Interface not intuitive.	Optimize the interface.
	Limited personalization and feedback.	Integrate features like chatbots, progress tracking, and learning recommendations.

CONCLUSION

The implementation of the local education (LE) subject in Vietnamese high schools continues to face challenges related to traditional lecture-based teaching, limited learning materials, and limited learning experience. This study proposes a novel learning system that integrates virtual reality (VR) into web and mobile applications to support the teaching and learning of the LE subject, with a particular focus on Grade 10 students in Lamdong province. The empirical findings show noticeable improvements in students' learning interest, engagement, and perceived understanding after the intervention. At the same time, teachers reported better instructional support, more effective lesson organization, and greater ease in implementing active and interdisciplinary teaching practices. The novelty of this study lies in its curriculum-aligned system design and large-scale empirical evaluation involving both teachers and students across multiple high schools, which makes it different from previous VR-based approaches that focus primarily on small-scale implementations. However, reliance on self-reported data and the short-term evaluation within a single provincial context can be considered the limitations of this study. Future research should incorporate objective learning measures, longitudinal assessment, and broader deployment to further validate the system's effectiveness. Moreover, future developments should also aim to improve system usability, enrich region-specific content, and incorporate features such as chatbots and gamified/personalized learning paths.

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