VIETNAM NATIONAL UNIVERSITY – HO CHI MINH CITY

THE INTERNATIONAL UNIVERSITY

SCHOOL OF COMPUTER SCIENCE AND ENGINEERING

WEB APPLICATION DEVELOPMENT

IT093IU

PROJECT FINAL REPORT

LMS - LEARNING MANAGEMENT SYSTEM

By Group 3PowerRangers - Members list

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3. Lê Viễn Phát — ITCSIU22213 (Team member)

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ACKNOWLEDGEMENTS

We would like to express our sincere gratitude to everyone who supported us in completing this report on the development of a Learning Management System.

First and foremost, we extend our deepest thanks to our instructor, Nguyen Trung Nghia, for his invaluable guidance, expertise, and encouragement. His insightful feedback and direction have been instrumental in shaping both the quality and progress of our work.

We would also like to acknowledge our team leader and members — Phạm Gia Phúc, Nguyễn Hồng Ngọc Hân, and Lễ Viễn Phát — for their commitment, effort, and teamwork. Each person's contributions, skills, and ideas played a vital role in the success of this project. The collaboration among us fostered creativity and helped us address challenges effectively.

Lastly, we are profoundly grateful to our families and friends for their patience, understanding, and continuous support throughout this journey. Their motivation and belief in us have been a constant source of strength and inspiration.

In conclusion, we wholeheartedly thank everyone who, in one way or another, contributed to making this project possible.

ABSTRACT

This report presents the development journey of **Byway**, an online Learning Management System (LMS) created to elevate the educational experience for both instructors and students. The platform addresses common challenges found in traditional learning settings by offering greater accessibility, flexibility, and engaging learning interactions. Developed with modern technologies such as ReactJS and NodeJS, and powered by a PostgreSQL database, Byway enables the integration of diverse multimedia resources within lessons and supports seamless communication between learners and educators. The system provides free access to a variety of technology-focused learning modules, equipping users with comprehensive tools designed to enhance and personalize their learning experience.

CHAPTER 1: INTRODUCTION

1. Background

In recent years, the rapid growth of digital technology has revolutionized the way education is delivered and consumed. Traditional classroom environments, while effective in fostering direct interaction, often face challenges such as limited accessibility, scheduling constraints, and a lack of flexibility for diverse learning needs. The increasing adoption of online platforms has created a shift toward digital learning ecosystems that allow students and educators to interact, collaborate, and track progress remotely.

Learning Management Systems (LMS) have emerged as essential tools for managing and organizing educational content, assessments, and communication. They provide centralized platforms where learners can access course materials, submit assignments, and receive feedback — while instructors can monitor student performance and manage classes efficiently. However, many existing LMS solutions are either too complex for small institutions or lack features that promote engagement, usability, and adaptability to different teaching contexts.

To address these gaps, this project introduces Byway, an intuitive and modern LMS web application designed to streamline teaching and learning processes. Byway aims to create an engaging, accessible, and user-friendly environment that supports both instructors and students through features like course management, progress tracking, and interactive content delivery.

2. Problem statement

Despite the availability of numerous LMS platforms, several persistent challenges remain:

- **Complexity and Poor User Experience:** Many LMS systems have cluttered interfaces or require extensive training, which discourages both educators and learners from using them effectively.
- **Limited Accessibility and Responsiveness:** Some systems fail to deliver a seamless experience across different devices, making it difficult for students to learn anytime and anywhere.

- **Lack of Interaction and Engagement:** Traditional LMS tools often focus on content delivery rather than fostering interactive and collaborative learning experiences.
- **Insufficient Performance Monitoring:** Instructors may find it difficult to track learners' progress in real time or identify areas where students struggle.

Therefore, there is a need for a lightweight yet powerful web-based LMS that emphasizes simplicity, interactivity, and accessibility while maintaining essential academic and administrative features.

3. Scopes and Objectives

3.1. Scopes

The purpose of this project is to develop and evaluate an online learning management system which is more comprehensive and effective for both learners and instructors. It can address the aforementioned challenges while enhancing user engagement and managing data effectively, and also providing the necessary functions to meet learner's needs. This effort intends to serve various demands of stakeholders, such as students, instructors, university administrators and corporate clients or enterprises.

3.2. Objectives

The primary objective of this project is to design and develop an online Learning Management System - Byway - that enhances the educational experience through intuitive design and robust functionality.

Specific objectives are displayed in this project:

- To provide a platform where instructors can create, manage, and publish courses with multimedia content.
- To allow students to enroll, view lessons, complete assignments, and monitor their own progress.
- To enable communication between instructors and students through discussion threads, announcements, or messaging tools.
- To implement user authentication and role management for secure access to course materials.
- To develop an admin dashboard for managing users, content, and system analytics.

- To ensure the system is responsive, accessible, and compatible across different devices and browsers.
- To integrate a database that securely stores user, course, and assessment information.

4. Customer requirements

The development of this platform aligns with the requirements outlined by the users, who emphasize the need for available online learning resources and an efficient tool to create their own set of study lessons.

5. Structure of the Report

- **Acknowledgements:** Expresses appreciation to individuals and organizations who provided support, guidance, or resources throughout the project.
- **Abstract:** Summarizes the project's purpose, development process, methodologies, key features, and final outcomes.
- **Chapter I – Introduction:** Presents the project background, team motivation, overall objectives, project scope, an overview of the system's implementation, and the structure of the report.
- **Chapter II – Project Timeline and Responsibilities:** Outlines the major project milestones, development timeline, assigned roles, and individual contributions of each team member.
- **Chapter III – Methodology:** Describes the approach taken to develop the system, including requirements gathering, database design, architectural design, and user interface development.
- **Chapter IV – Implementation and Results:** Details the implementation process for both the frontend and backend components, system integration, and testing outcomes.
- **Chapter V – Discussion and Evaluation:** Analyzes the project results, compares them with the initial goals, and discusses key observations, limitations, and insights gained during development.
- **Chapter VI – Conclusion:** Summarizes the overall achievements, highlights challenges faced, and proposes potential improvements or future extensions of the system.

CHAPTER 2: PROJECT TIMELINE AND RESPONSIBILITY

1. Project Timeline and Milestones

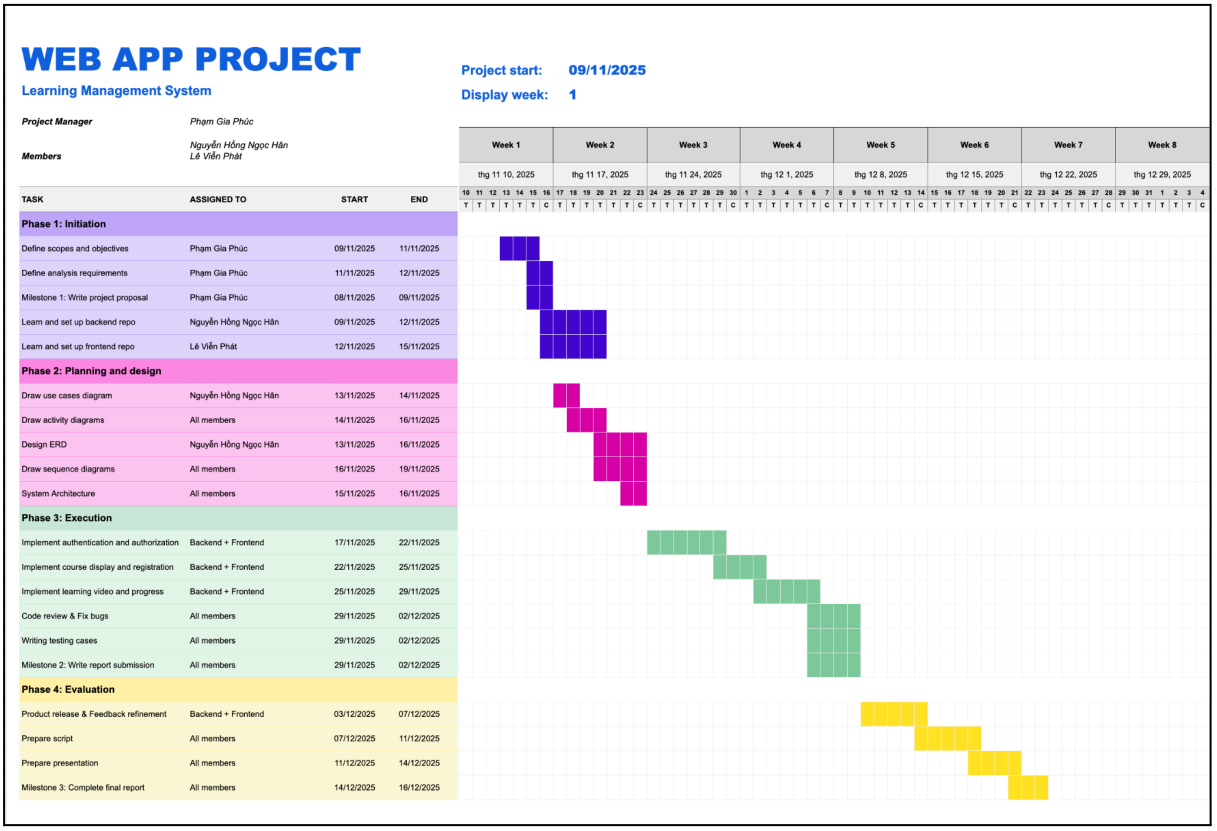


Figure 2.1: Gantt Chart

The project officially starts on 03/11/2025 and will end at the beginning of December, estimated time: 16/12/2025. Over the course of 7 weeks (midterm weeks excluded), our project will undergo four primary phases: project initiation, project planning and design, project execution and project evaluation

Three major milestones are integrated within these phases to meet the required deliverables: the Project Proposal, the Midterm Report, and the Final Report.

- **Milestone 1:** Project proposal submission: by this milestone, the project plan with a detailed timeline, feasibility study and requirements gathering need to be finished. The design phase is ongoing.
- **Milestone 2:** Midterm report submission: by this milestone, the requirements analysis (Use case, Activity, Sequence diagrams) needs to be finished. The

development of the product needs to be finished by 40% and documented in the midterm report.

- **Milestone 3:** Final report submission, the product needs to be ready for the soft launch, with functional testing and detailed technical documents.

2. Responsibility

Table 2.1 Member's role and responsibility table

Name	Student ID	Role	Contribution
Phạm Gia Phúc (Team leader)	ITCSIU22178	Full stack	32%
Nguyễn Hồng Ngọc Hân (Member)	ITCSIU22229	Backend	34%
Lê Viễn Phát (Member)	ITCSIU22213	Frontend	34%

It is important to note that a member's contribution is evaluated not only based on the tasks they are assigned but also on their efforts to generate ideas, contribute to the overall development of the product, meet deadlines consistently, and collaborate effectively with other team members.

CHAPTER 3: METHODOLOGY

1. User requirements analysis

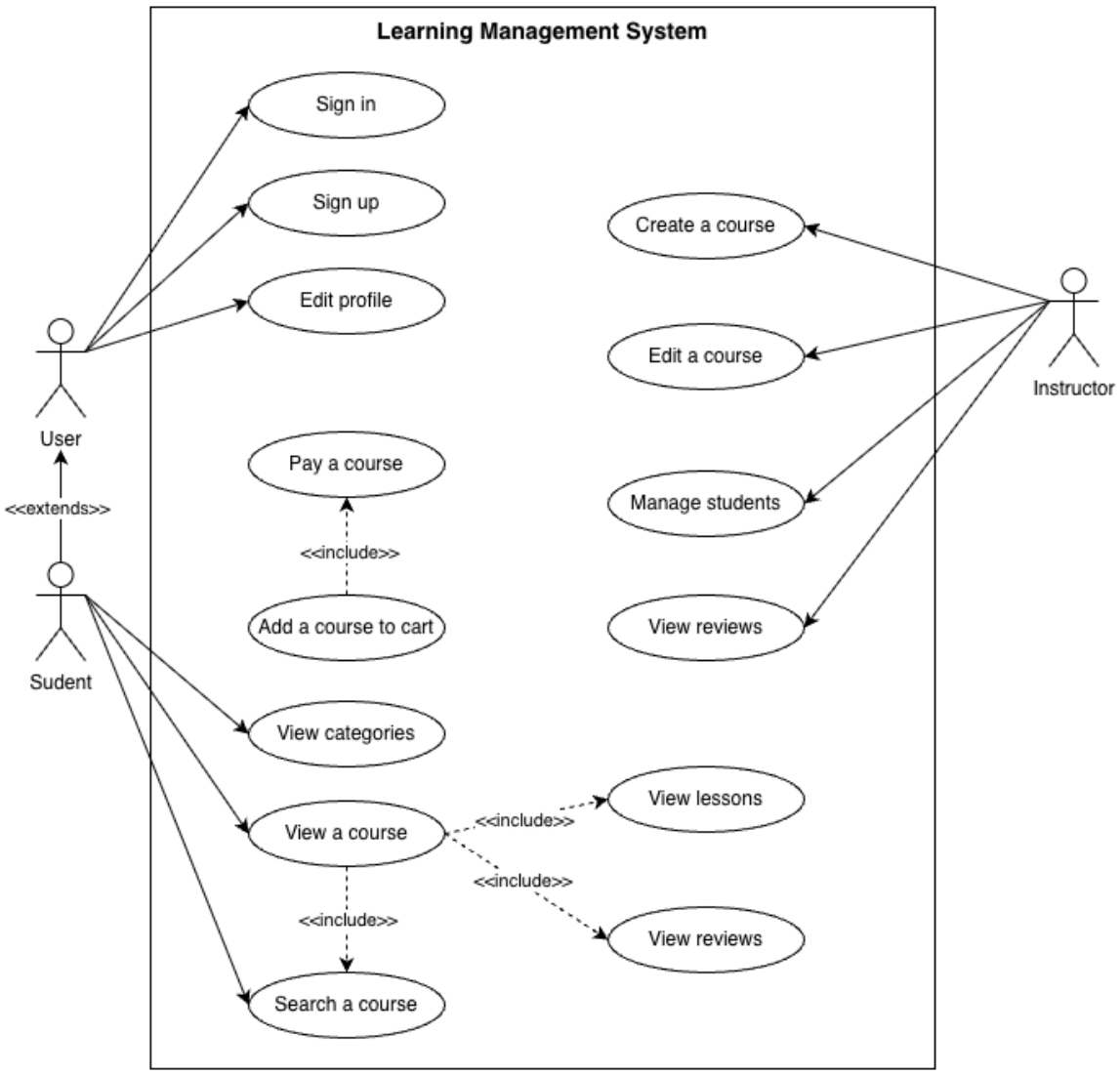
Table 3.1. Functional requirements and Non-functional requirements

Requirement Type	ID	Name	Description
Functional Requirements	001	Authentication and authorization	The system should allow third-party login and have two-factor authentication via Gmail. Password recovery should be enabled.
	002	User interface	The user interface should be intuitive and user-friendly.
	003	Uploading course materials	Instructors should be able to upload lesson materials, including documents, videos, quizzes, and assignments.
	004	Course search and filter	Courses can be searched by names or categories.
	005	Progress Tracking	Students' progress should be transparent to the instructor and to the students themselves.
Non-functional Requirements	006	Performance	The system should handle up to 5,000 concurrent users efficiently with minimal latency.
	007	Response time	Response time should be under 1 seconds.
	008	Data security	The system will follow current privacy and data protection rules which consist of permission controls and using cookies in the right ways.

	009	Usability	Learners should be able to view desired courses within 3 clicks from the homepage.
	010	Maintainability	Backup and recovery mechanisms must be in place to ensure no data loss in the event of system failures.

2. Use case diagram

Figure 3.1. Use case diagram



This use case diagram describes the interactions of the Online Learning Management System. It includes three actors, namely User, two of its inheritors which are Student and

Instructor. Each actor participates in a corresponding use case, sometimes collaborating to perform a function with the help of the system.

3. Activity diagrams

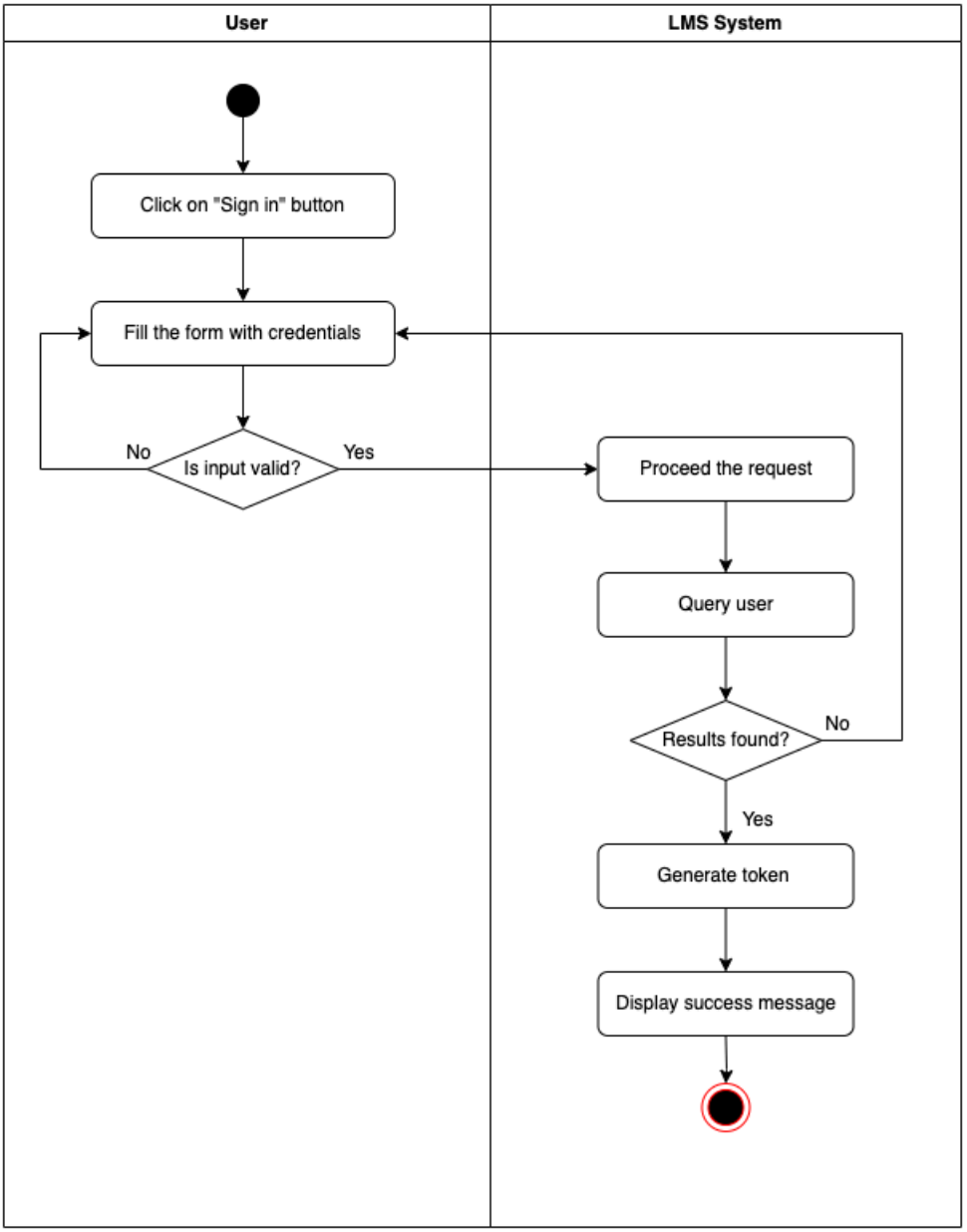


Figure 3.2 Sign in

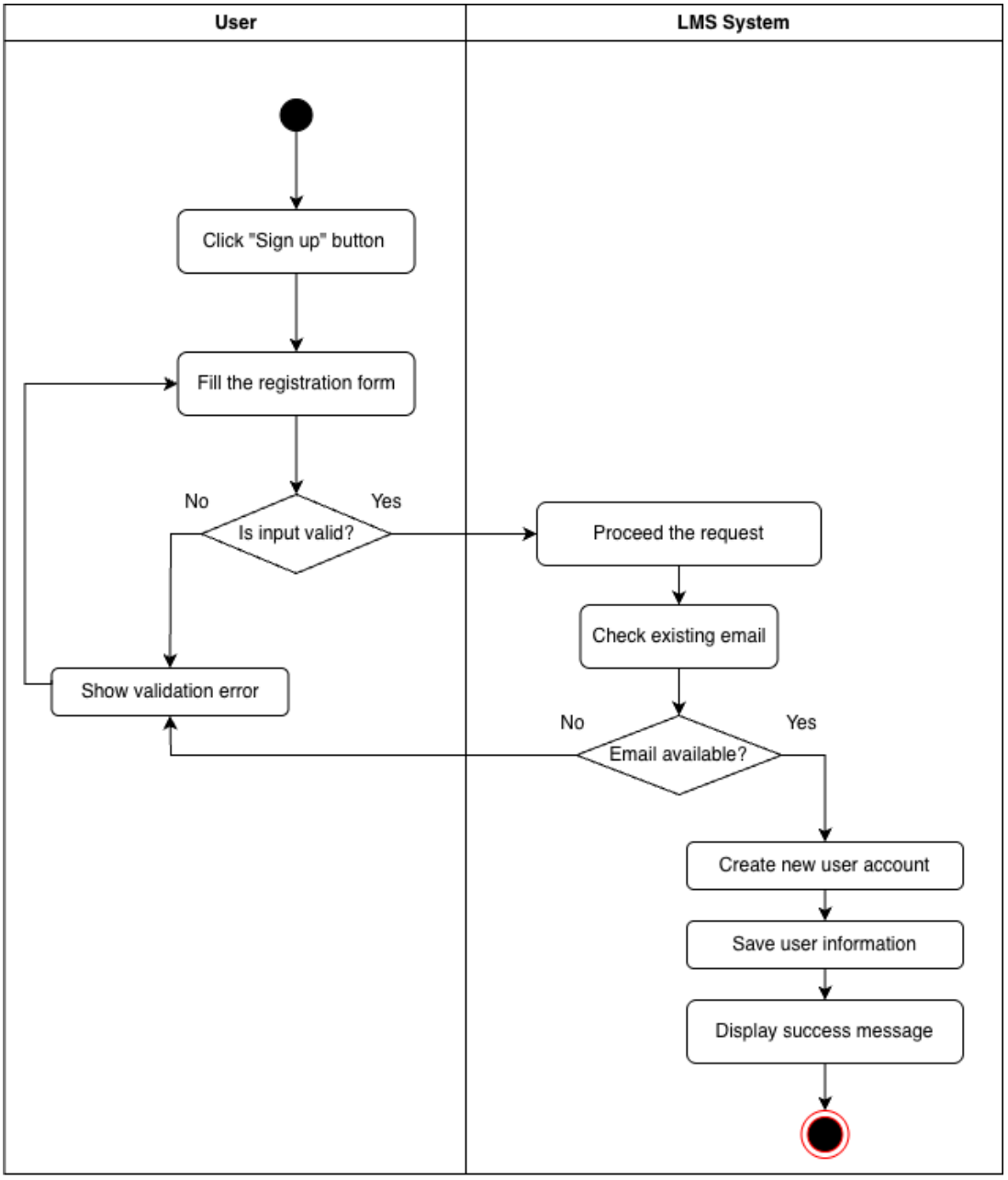


Figure 3.3 Sign up

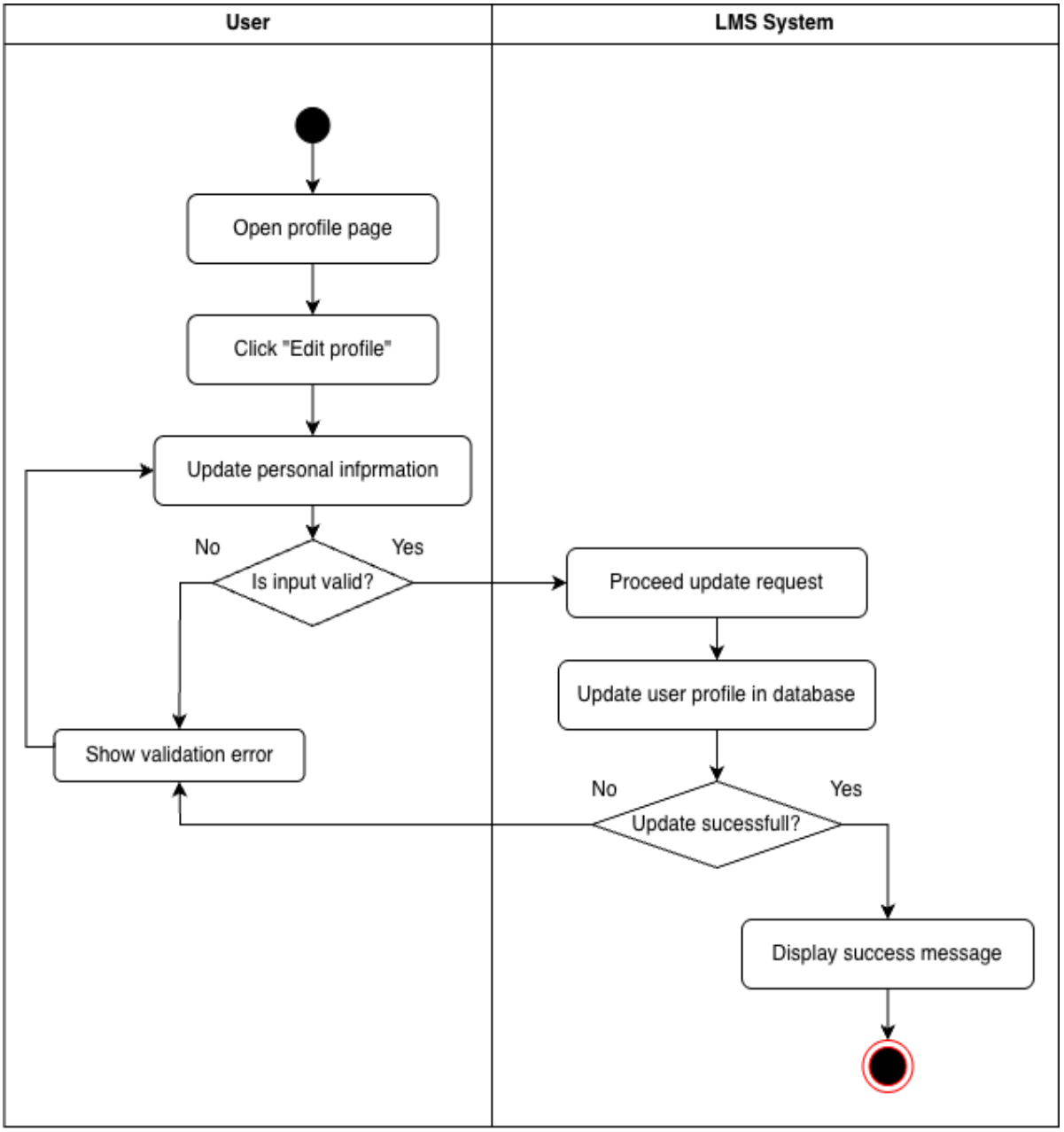


Figure 3.4 Edit profile

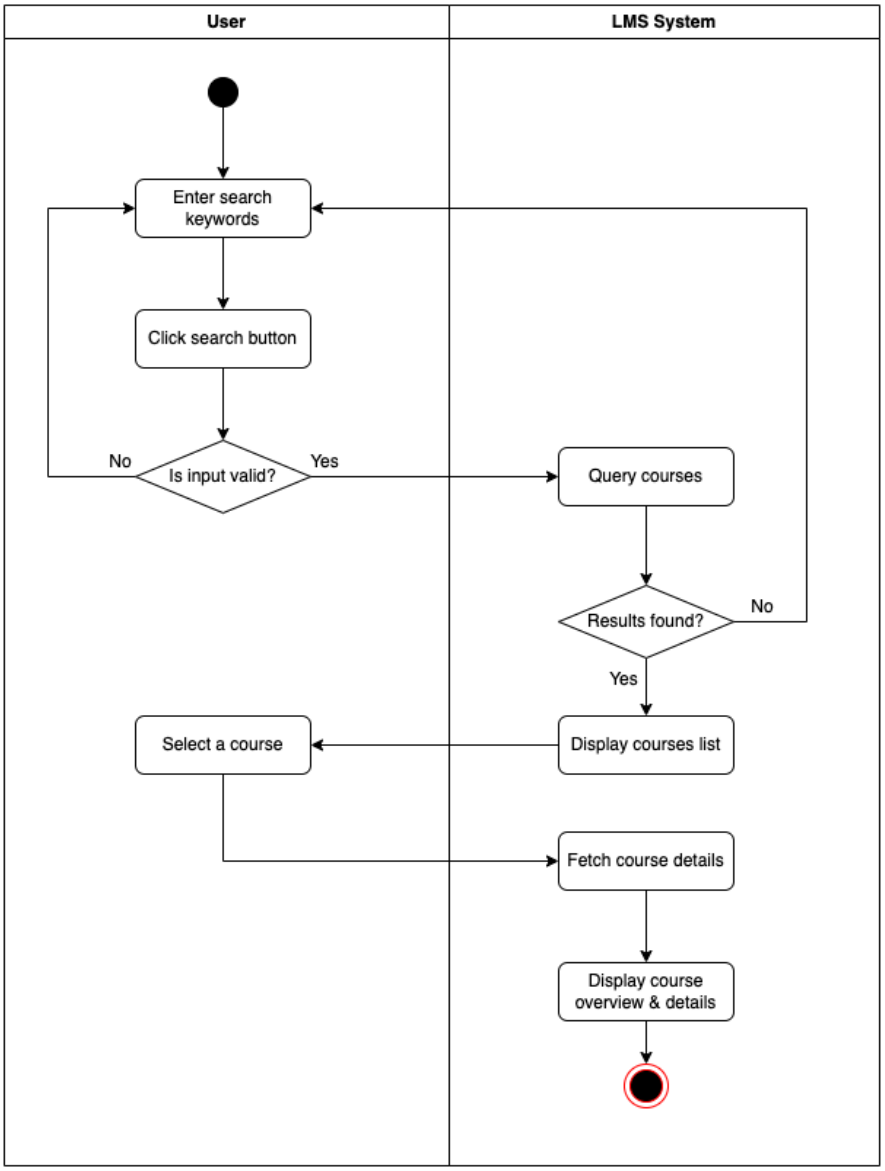


Figure 3.5 Search and view a course

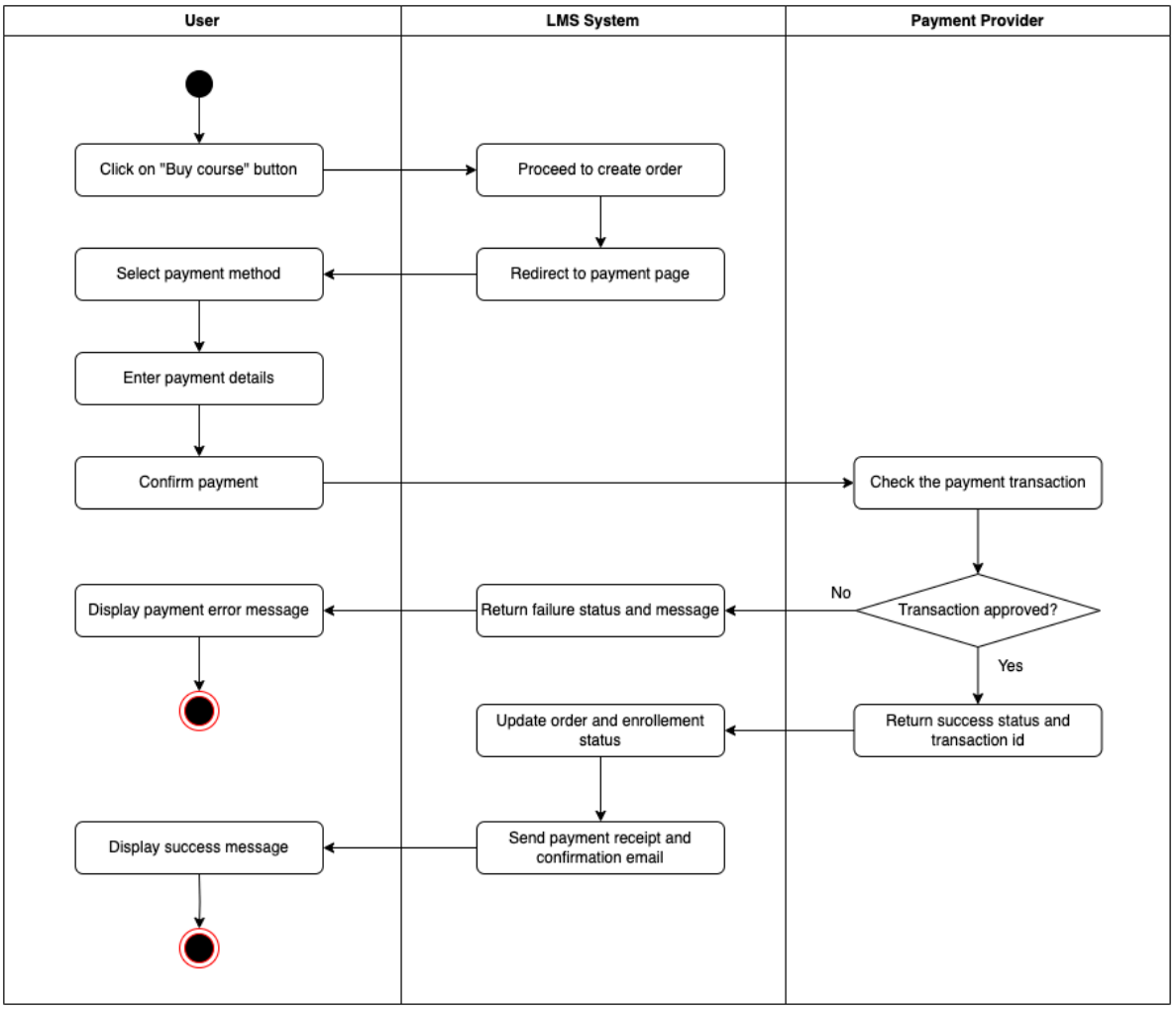


Figure 3.6 Pay a course

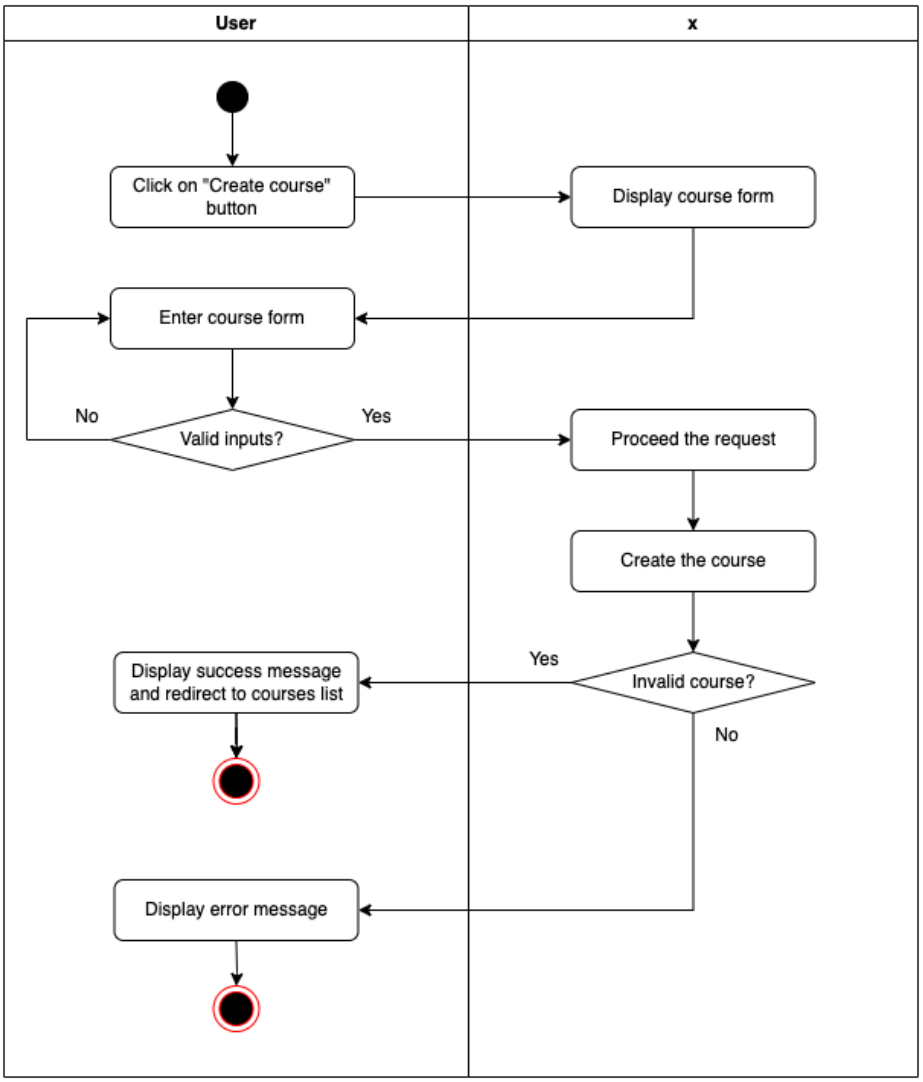


Figure 3.7 Create a course

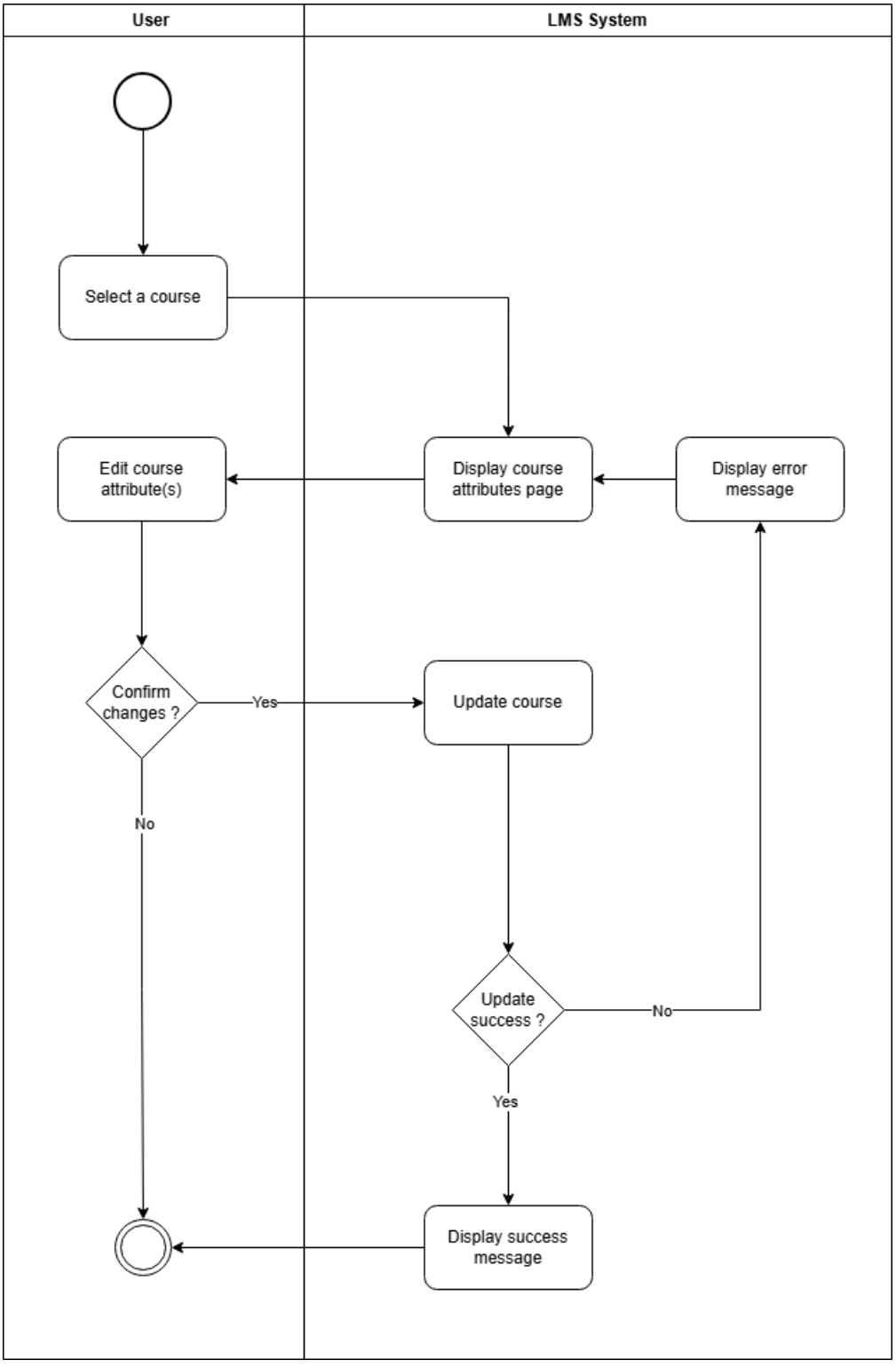


Figure 3.8 Edit a course

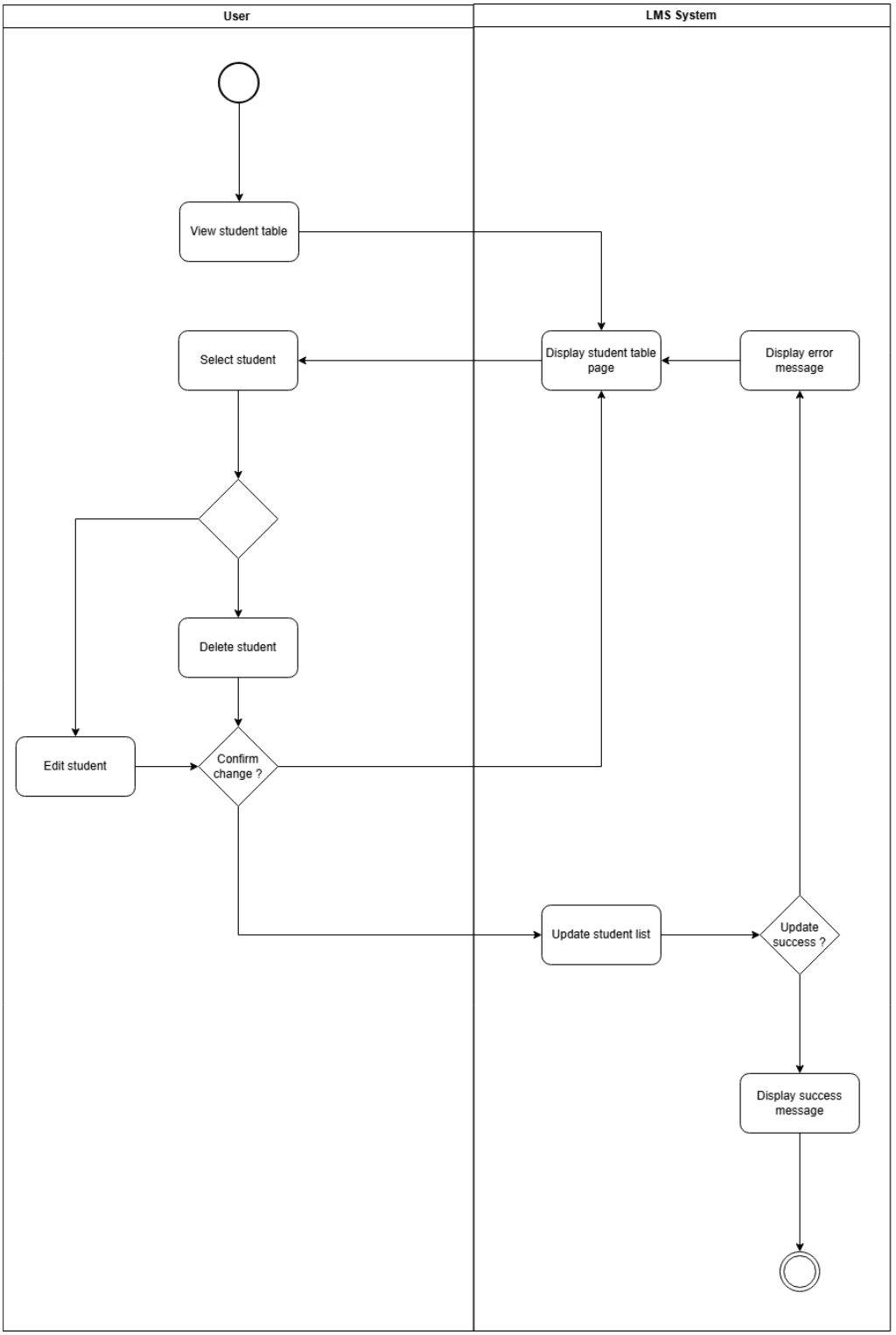


Figure 3.9 Manage students

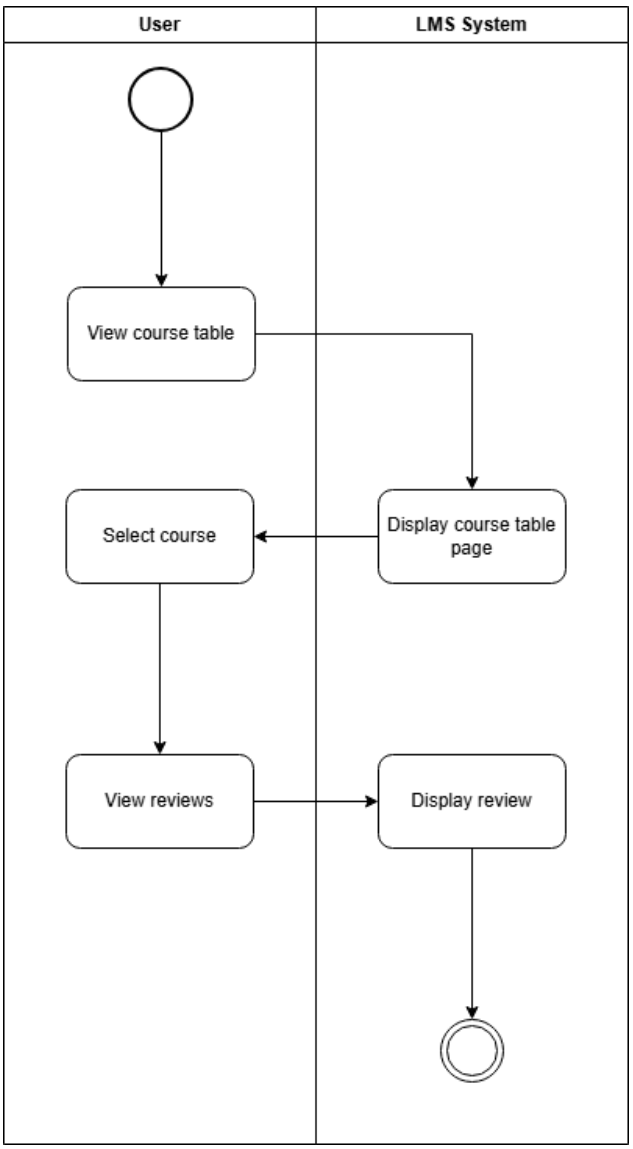


Figure 3.10 View reviews

4. Sequence diagrams

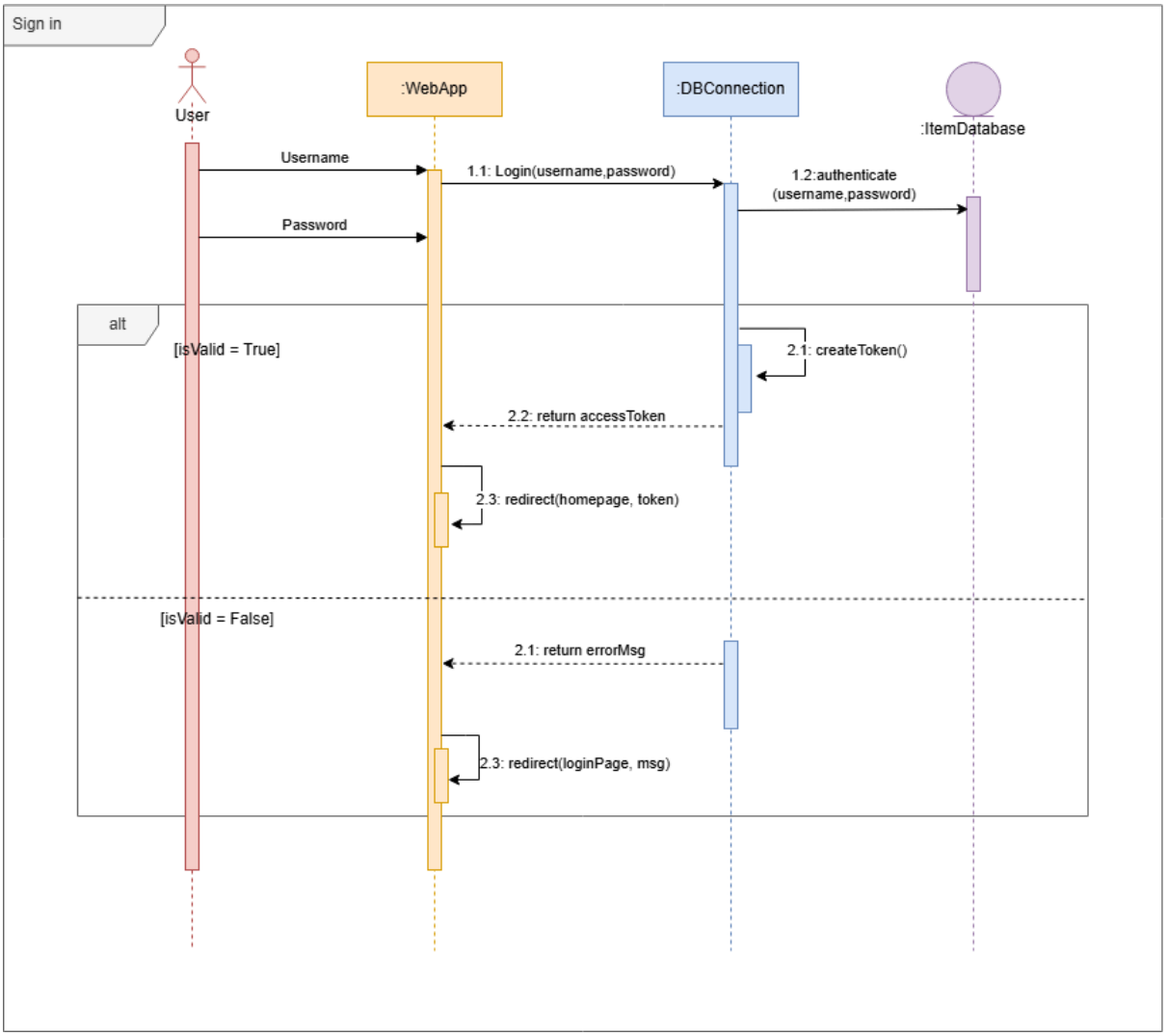


Figure 3.11 Sign in

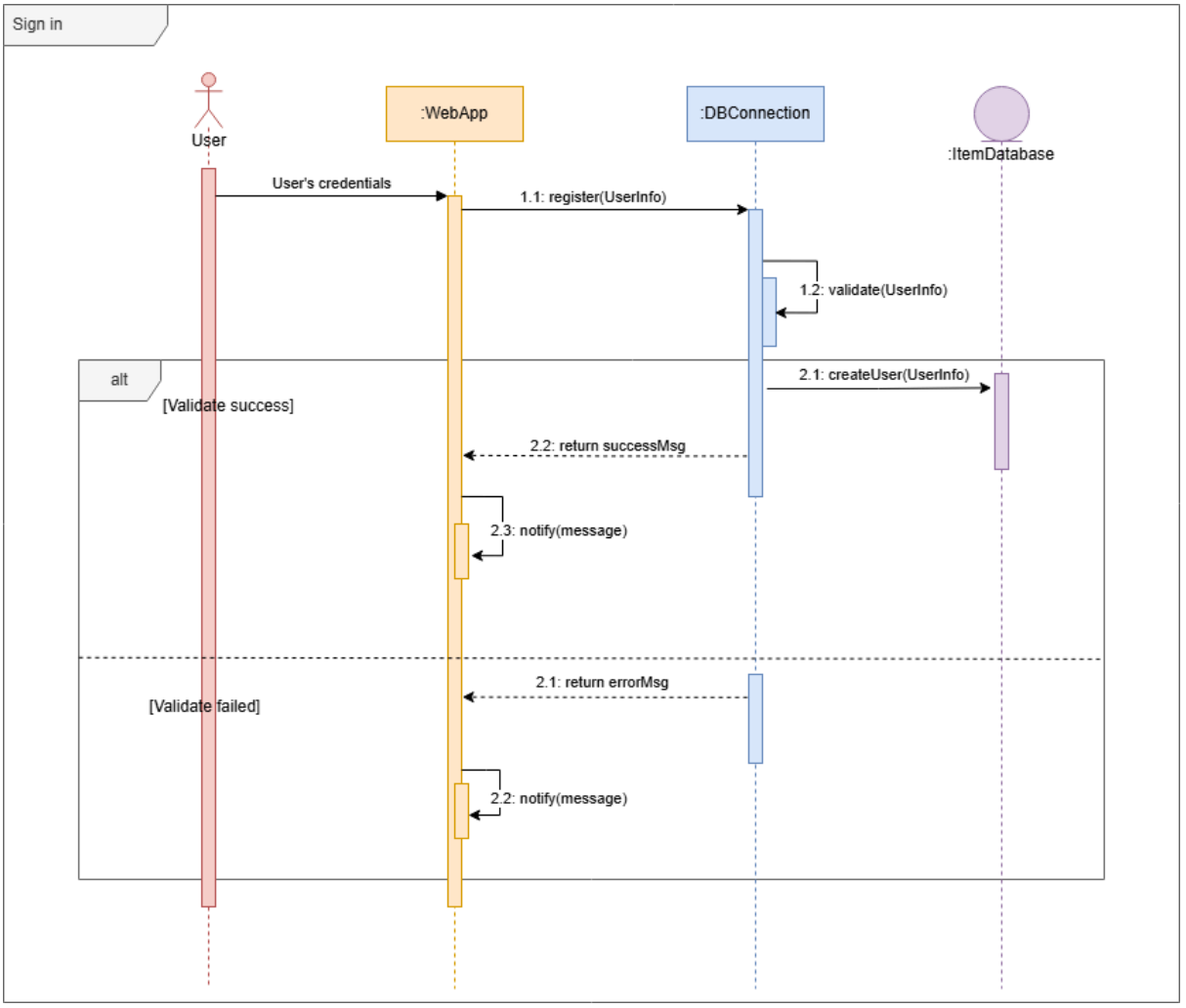


Figure 3.12 Sign up

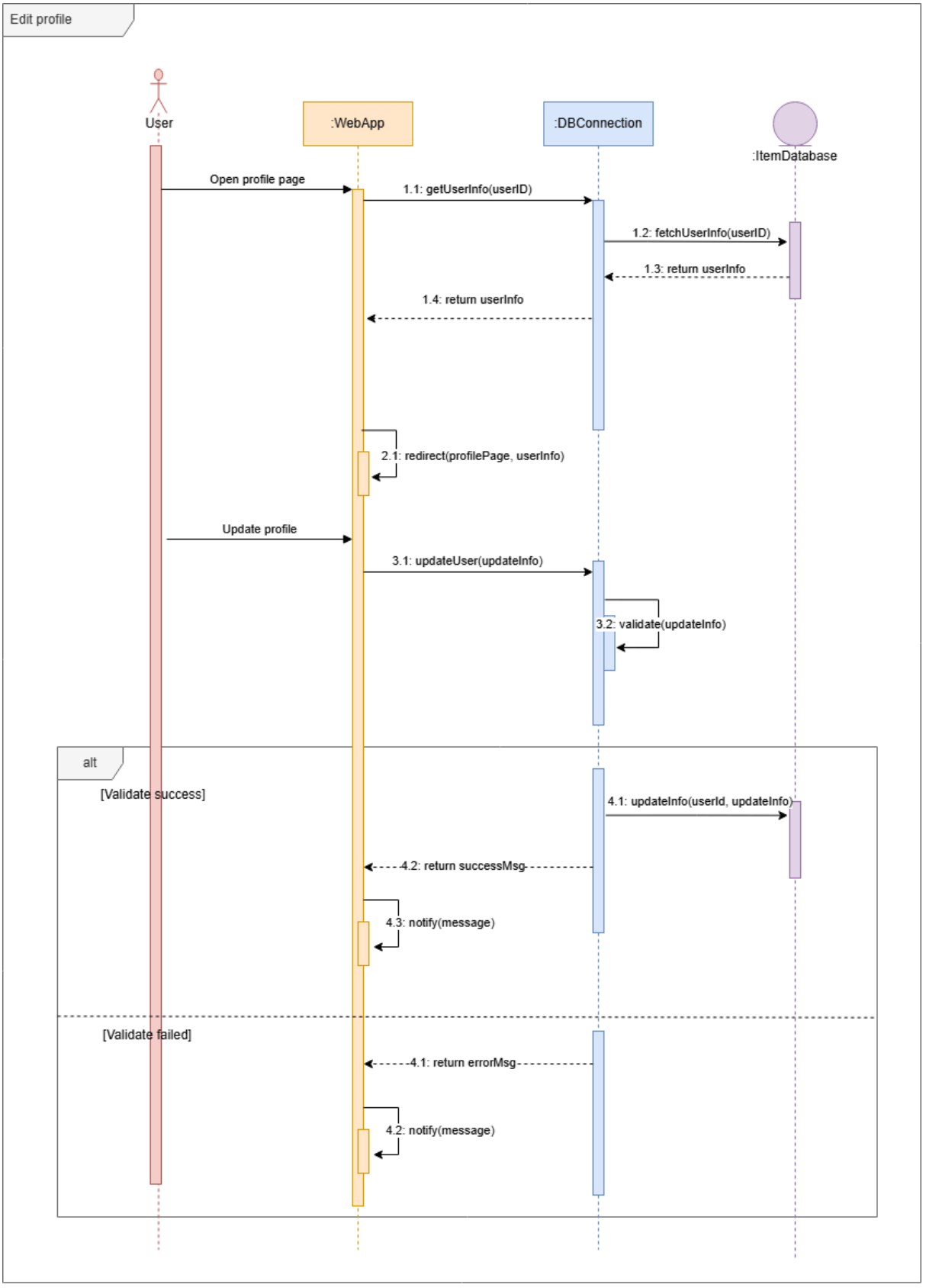


Figure 3.13 Edit profile

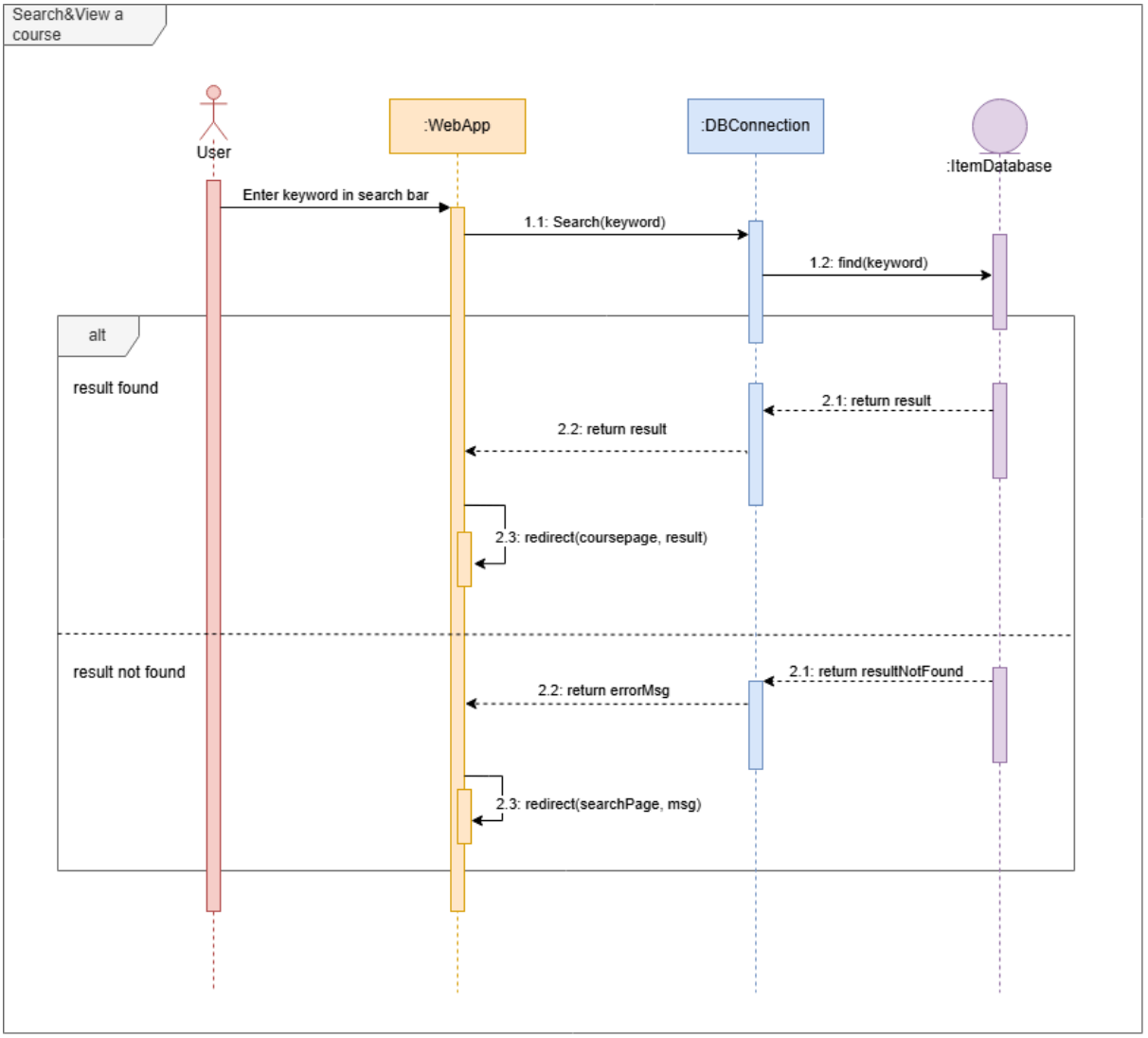


Figure 3.14 Search and view a course

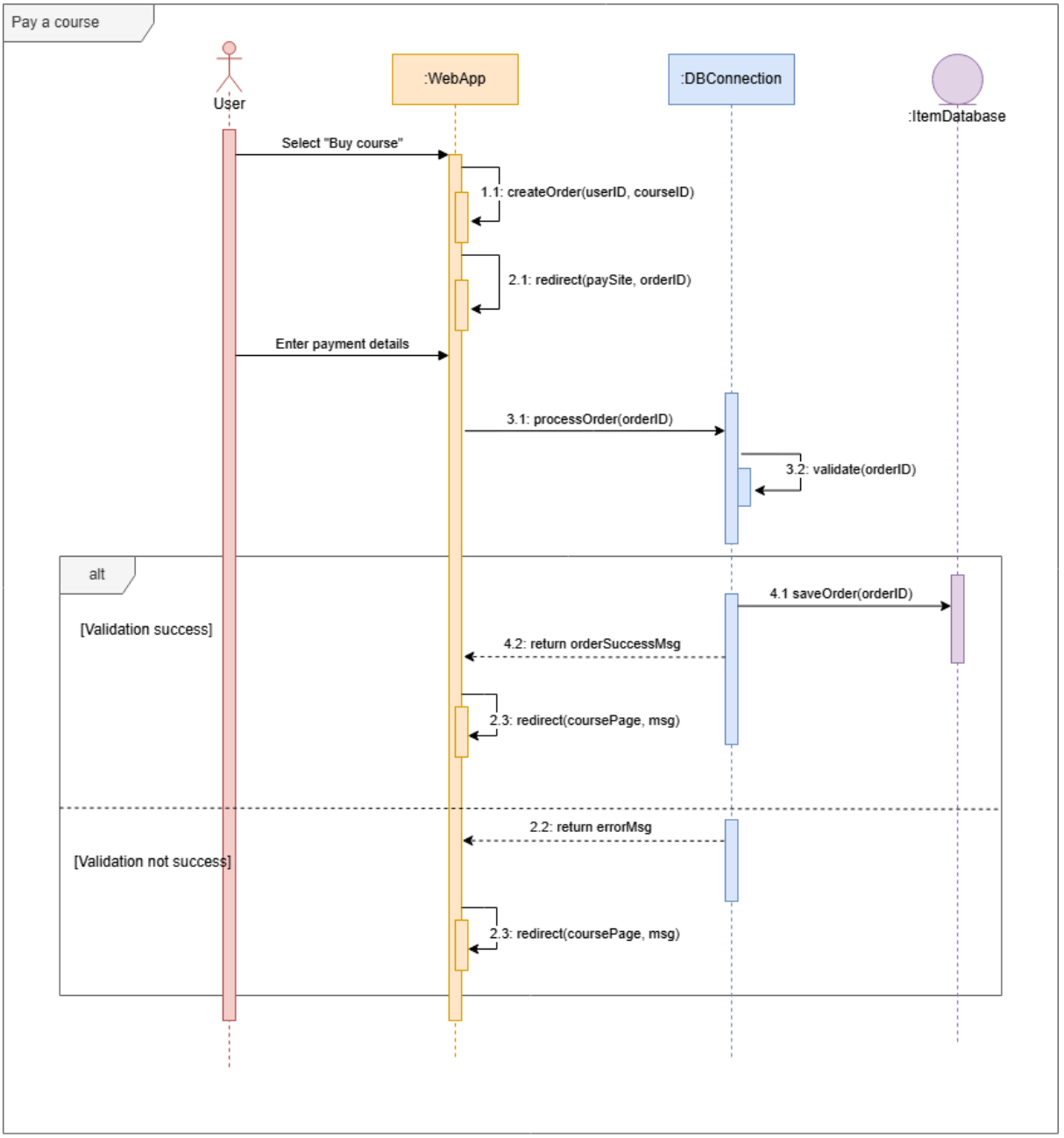


Figure 3.15 Pay a course

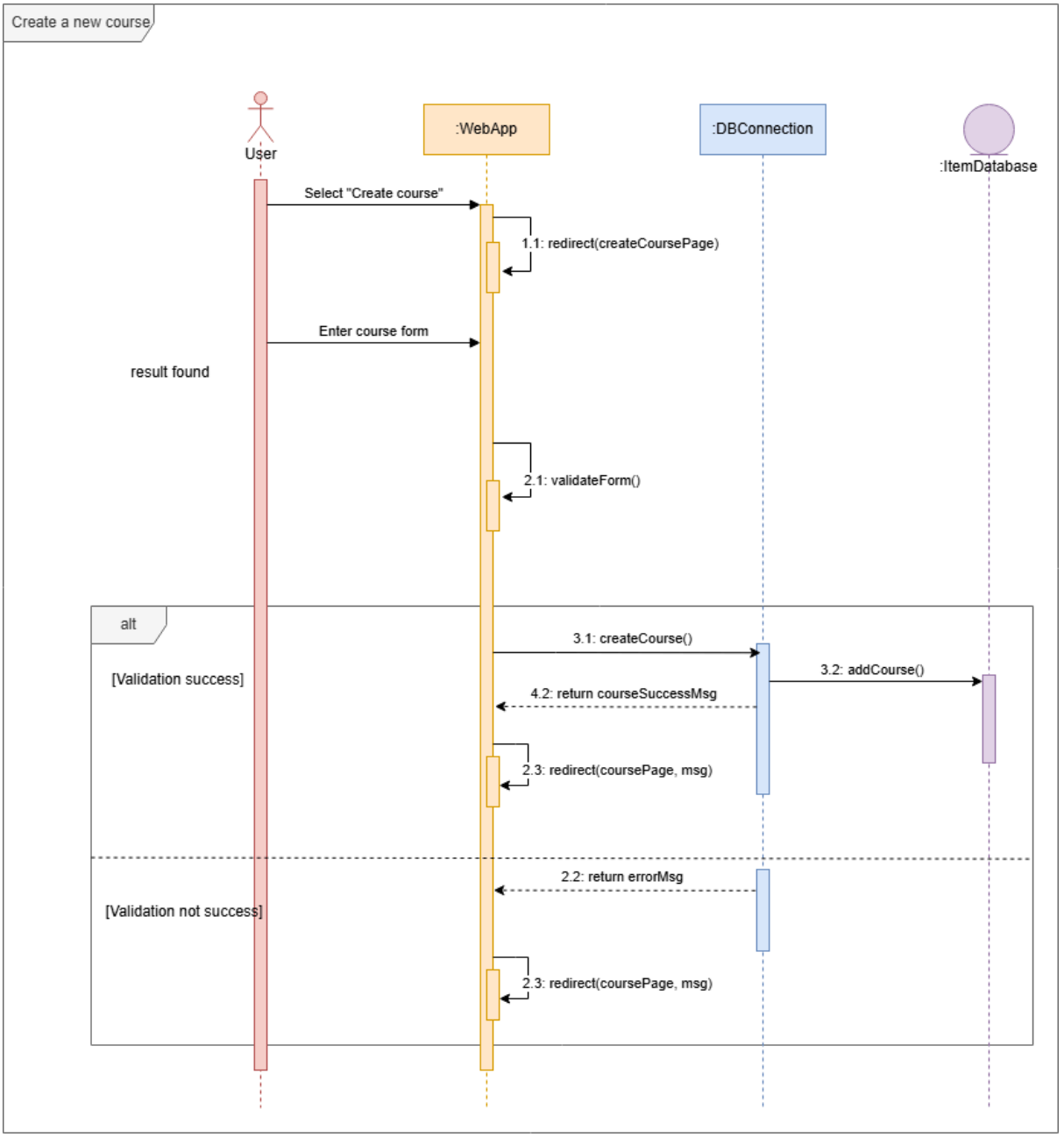


Figure 3.16 Create a course

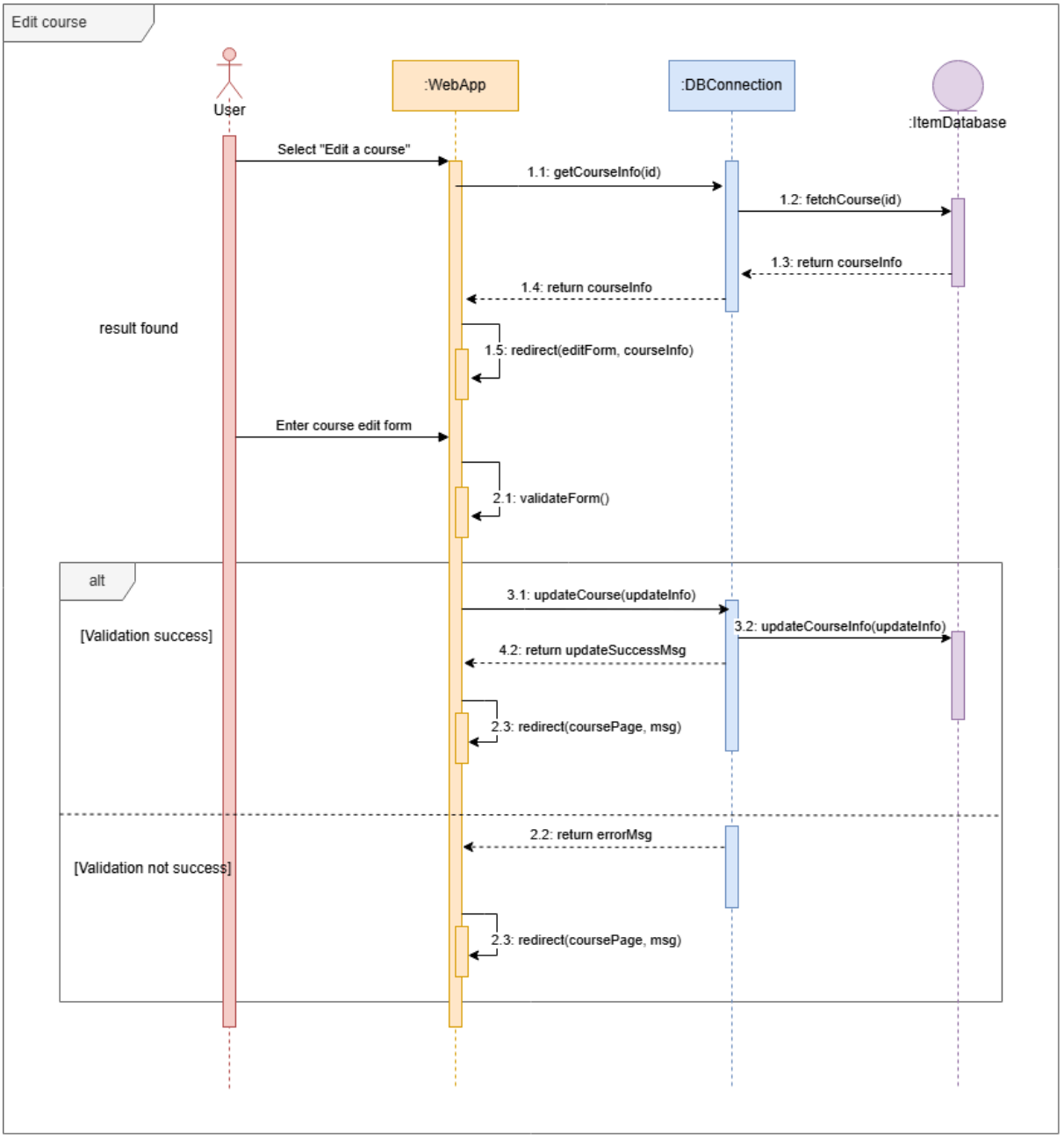


Figure 3.17 Edit a course

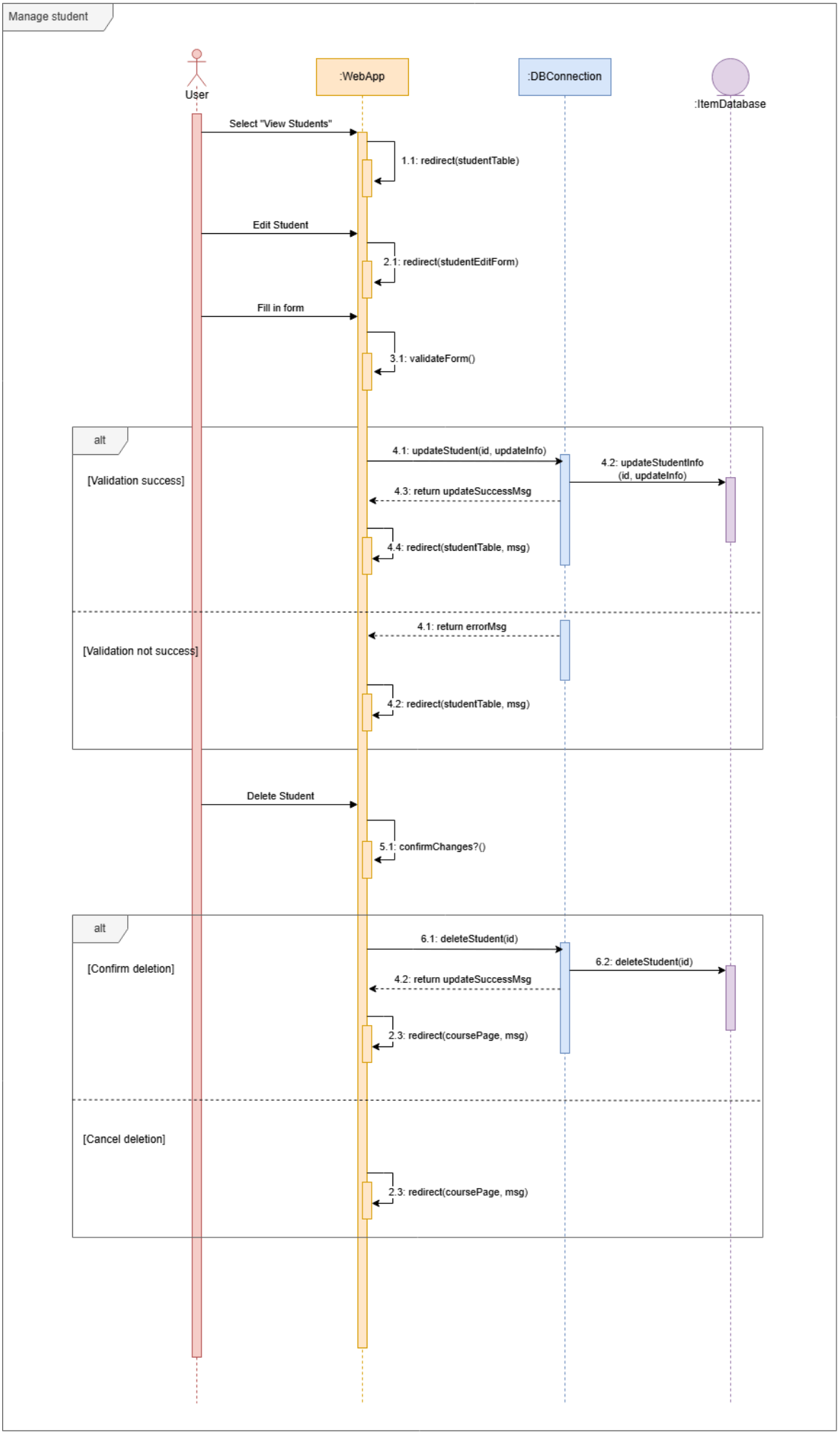

Manage student
User
:WebApp
:DBConnection
:ItemDatabase
Select "View Students"
1.1: redirect(studentTable)
Edit Student
2.1: redirect(studentEditForm)
Fill in form
3.1: validateForm()
alt
[Validation success]
4.1: updateStudent(id, updateInfo)
4.2: updateStudentInfo
(id, updateInfo)
4.3: return updateSuccessMsg
4.4: redirect(studentTable, msg)
[Validation not success]
4.1: return errorMsg
4.2: redirect(studentTable, msg)
Delete Student
5.1: confirmChanges?()
alt
[Confirm deletion]
6.1: deleteStudent(id)
6.2: deleteStudent(id)
4.2: return updateSuccessMsg
2.3: redirect(coursePage, msg)
[Cancel deletion]
2.3: redirect(coursePage, msg)

Figure 3.18 Manage students

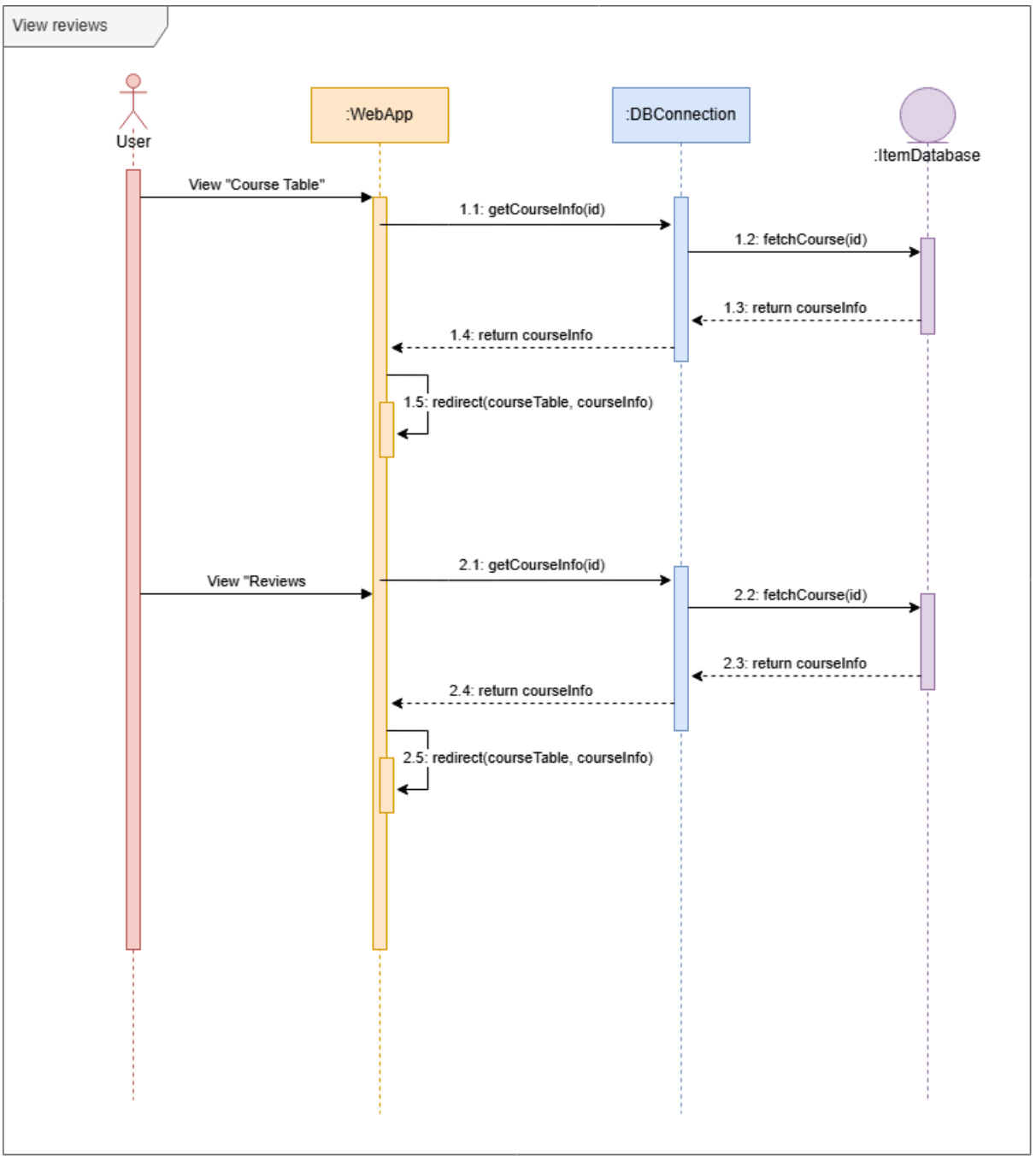


Figure 3.19 View reviews

5. System design

Model-View-Controller (MVC): The LMS adopts an MVC architectural pattern to effectively separate the presentation, business logic, and data layers. This structure enhances code organization, supports testing, and enables modular development for efficient system maintenance and growth.

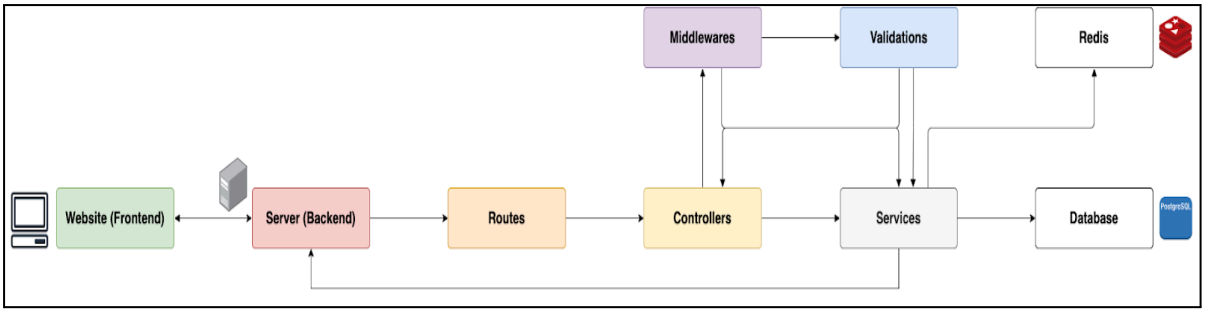


Figure 3.20. Model-View-Controller Diagram

6. Database design

6.1. ERD design

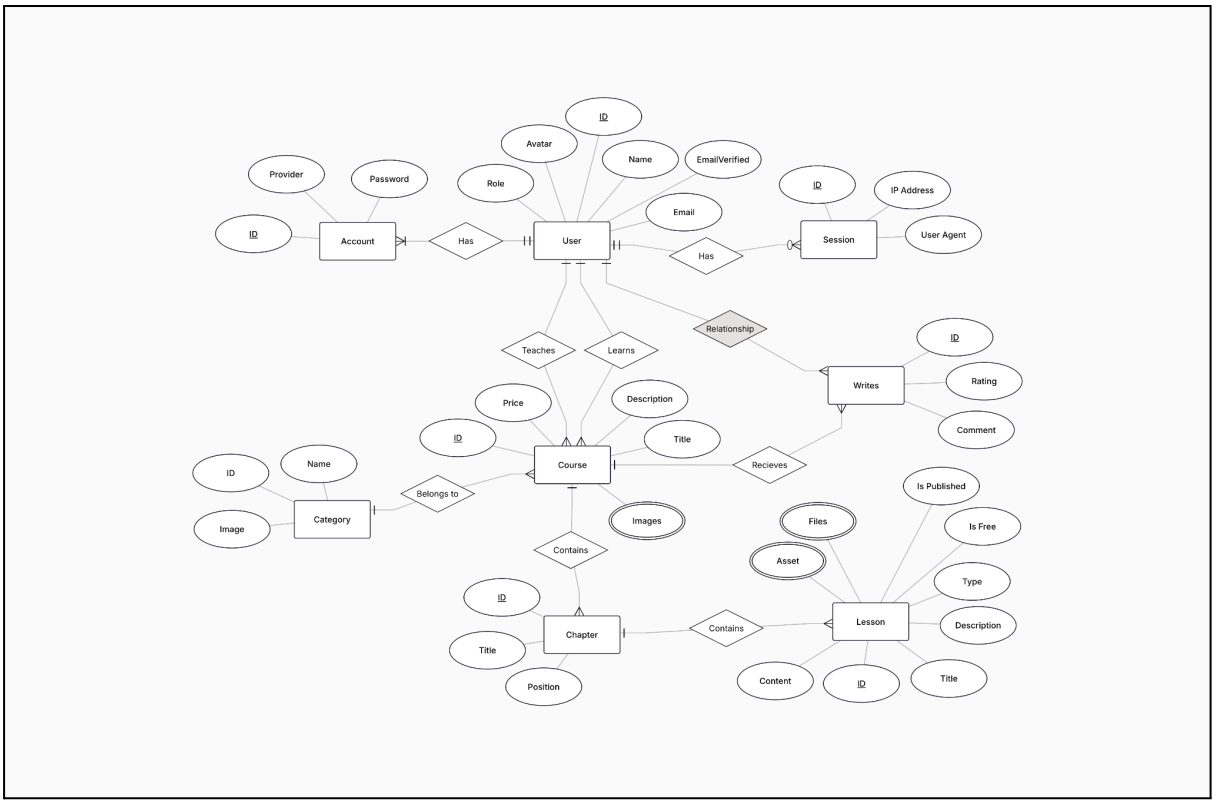


Figure 3.21. ERD design

6.2. Schema design

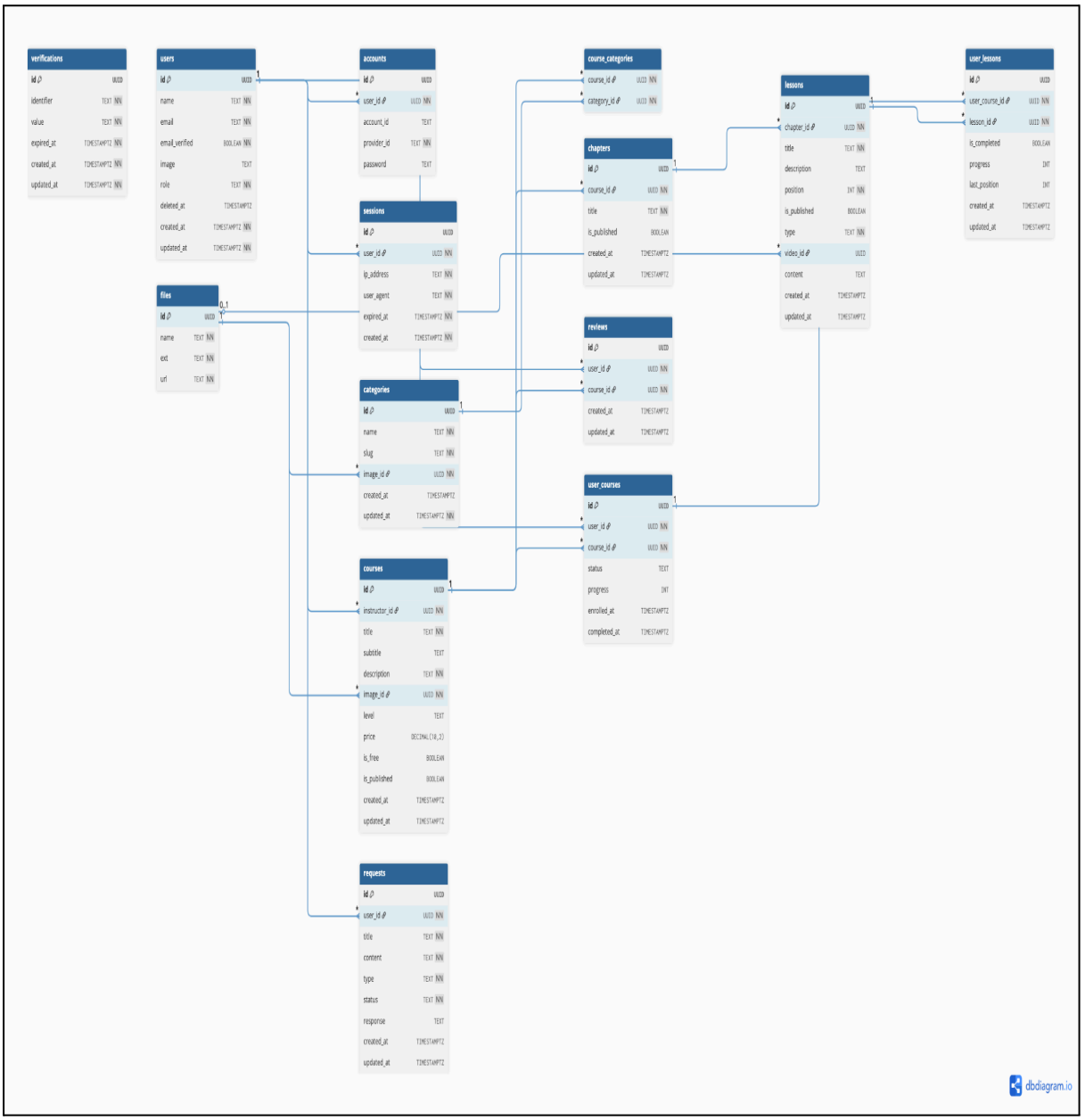


Figure 3.22. Database design

7. User interface design

The user interface (UI) design of Byway LMS is focused on intuitiveness, convenience, and user-friendly experience. The design process was carried out using figma, where wireframes, prototypes, and interactive flows were carefully crafted to ensure usability. Components were selected from the ShadCN Figma design library to maintain design consistency across devices.

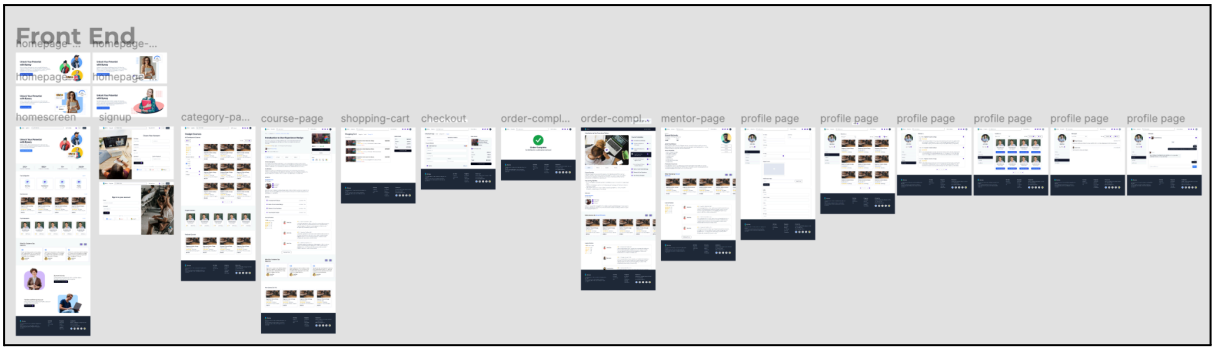


Figure 3.23. Interface design

CHAPTER 4: IMPLEMENTATION AND RESULT

1. Implementation

1.1. Overview

To implement the online learning management system, our group utilizes the following tools and programming languages:

+ **UI/UX design:** Figma is utilized to design the user interface (UI).
+ **Front-end development:** The front end of the project is developed using the React framework and TypeScript, complemented by the Tailwind component library ShadCN.
+ **Back-end development:** The backend is built with TypeScript and Node.js.
+ **Database management:** PostgreSQL is the chosen database for storing and managing project data. ERDPlus and Lucidchart are used to create the Entity-Relationship Diagram (ERD).
+ **Version Control:** GitHub serves as the primary platform for version control and collaboration among team members.
+ **Project Management:** GoogleSheet provides the primary workspace for the team.

Here are the links to our implementation's resources:

Table 4.1 Resources links

Section	Link
UI/UX (Figma)	https://www.figma.com/design/SlVFiOetiHacEH1daPCNwu/Learning-Management-System--Community---Copy-?node-id=410-10726&p=f&t=8vcAkCYJ5pg9mzn5-0
Backend	https://github.com/phamgiaphuc/byway-lms-be
Frontend	https://github.com/phamgiaphuc/byway-lms-fe

1.2. Frontend

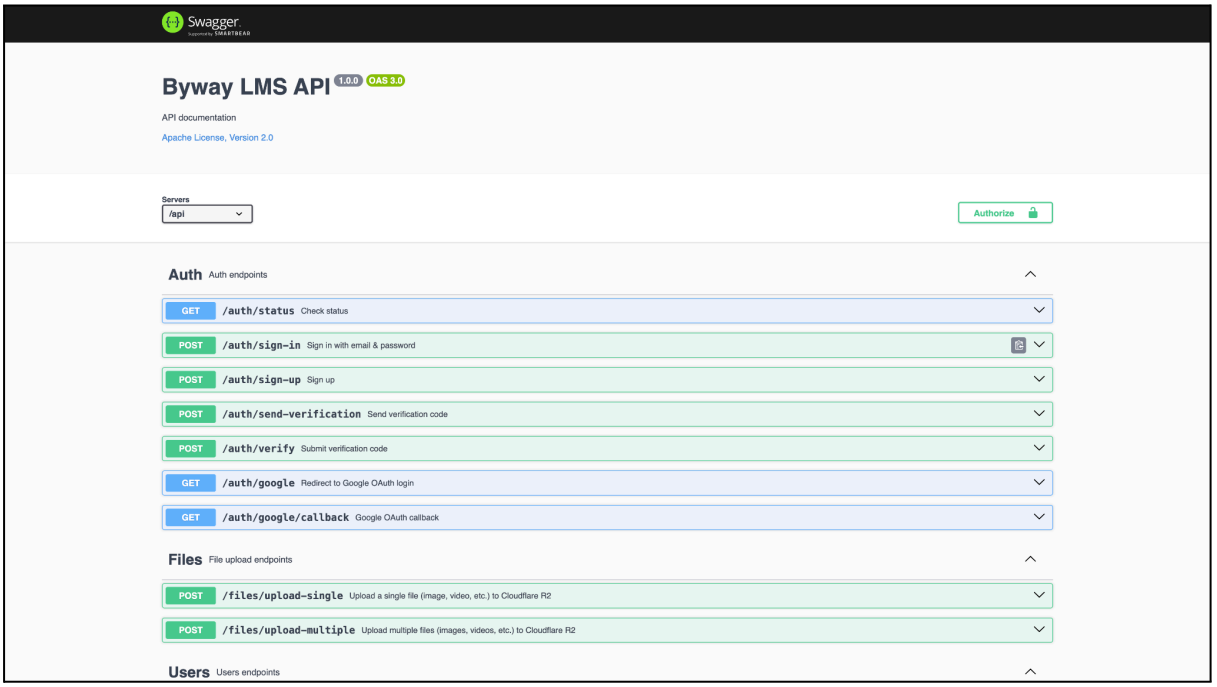
To build our frontend, here is the list of tools, programming languages, and dependencies that we used:

+ **Programming language:** TypeScript and ReactJS
+ **Framework:** Vite and Tanstack Router
+ **UI Library:** ShadCN
+ **Icon Library:** Lucide Icons
+ **State Controller:** Zustand
+ **HTTP Client Library:** Tanstack Query and Ky
+ **Others:** Prettier, ESLint, Husky and React Hook Form.

1.3. Backend

The backend of the Byway LMS was developed with a focus on scalability, maintainability, and security. This section outlines the key aspects of the backend implementation, including the technologies utilized, architectural patterns adopted, and deployment strategies:

+ **Programming language:** TypeScript
+ **Framework:** Express
+ **Database:** PostgreSQL
+ **ORM:** Prisma
+ **Storage:** R2 Storage (Cloudfare)



2. Results

2.1. Authentication and authorization

When registering for a new account, the user will be asked to fill in the sign up form, which consists of first, last name, email, username, password and password confirmation.

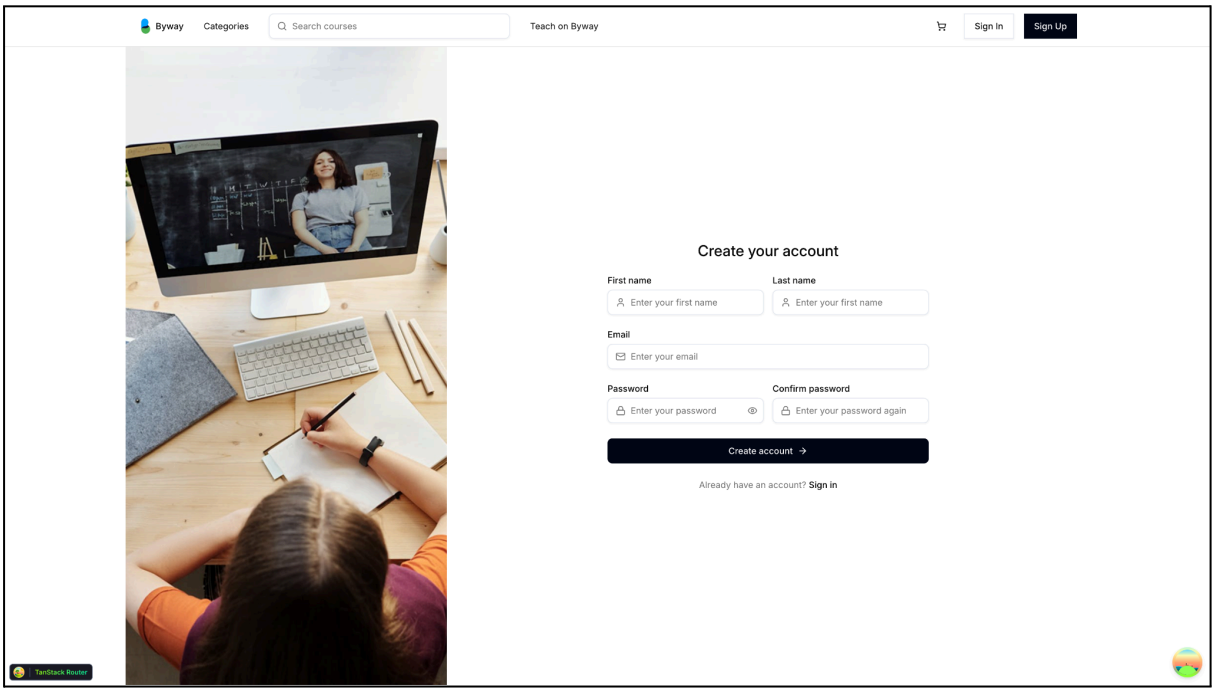


Figure 4.2. Sign up form

After filling in the sign-up form, the system will send a verification email to the registered address to ensure the authenticity and ownership of the email. The user needs to enter the OTP correctly to activate their account.

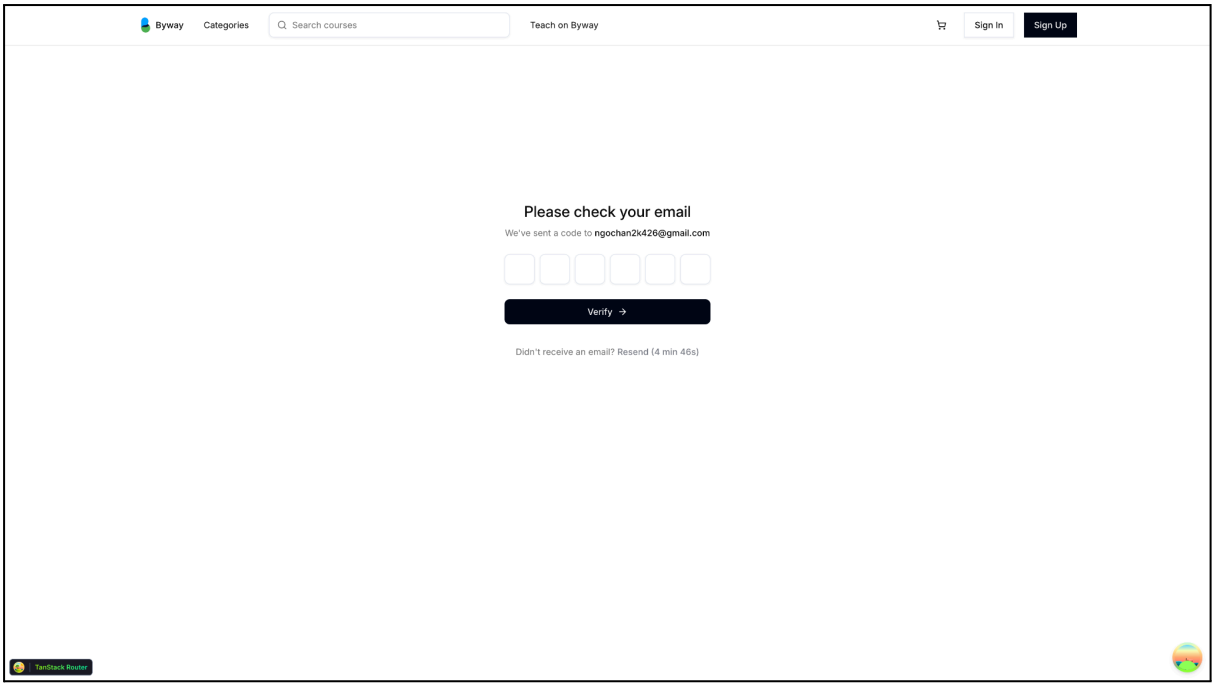


Figure 4.3. Email verification form

2.2. Home page

When users first access Scholaro, they are greeted with the hero section, which displays some of the popular categories and courses of the site. In order to enroll in courses, students will have to sign in to their accounts.

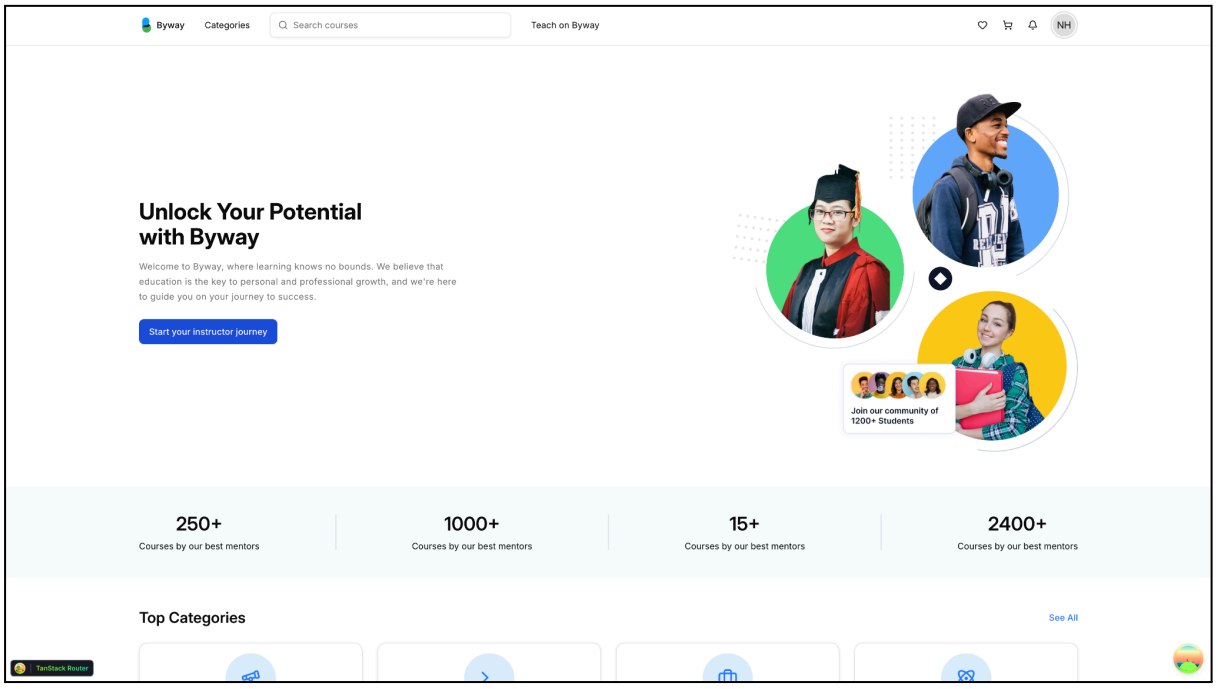


Figure 4.4. Hero section

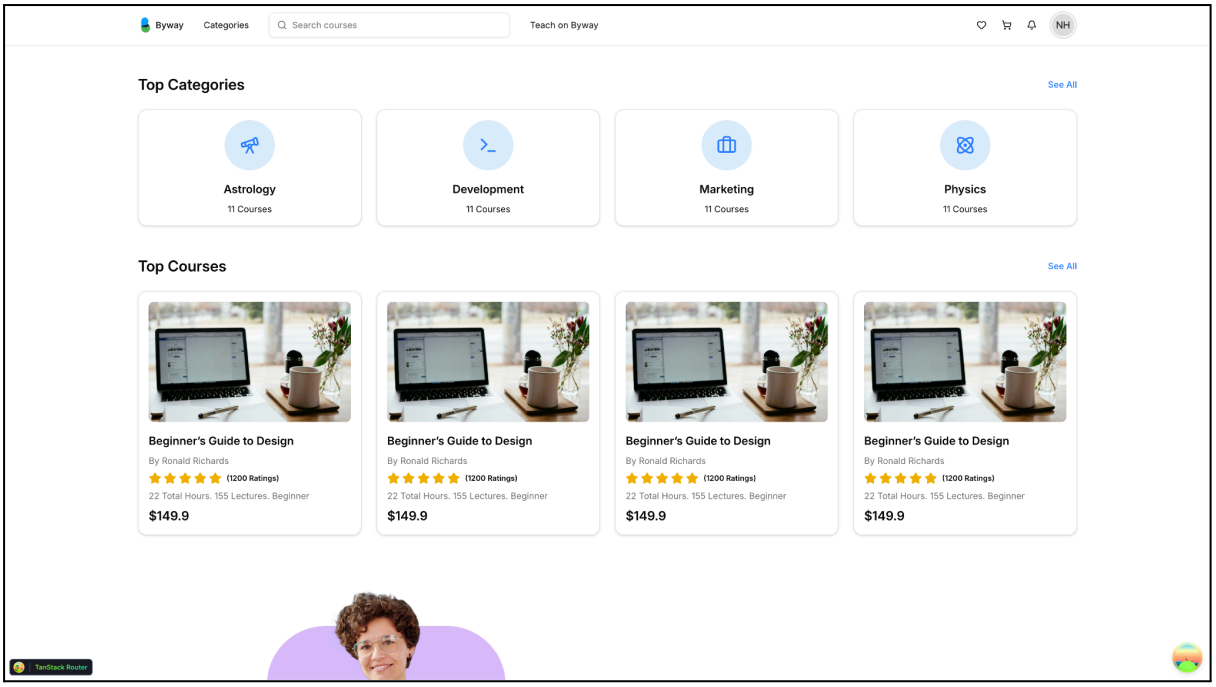


Figure 4.5. Category and Course section

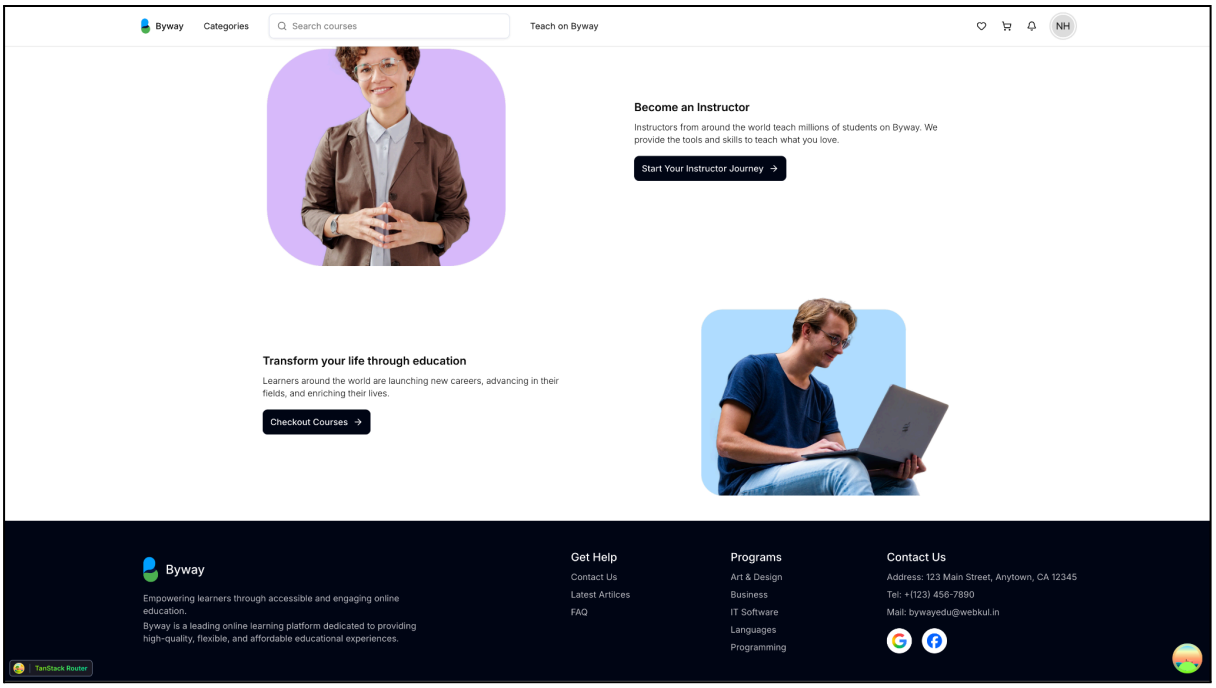


Figure 4.6. Footer section

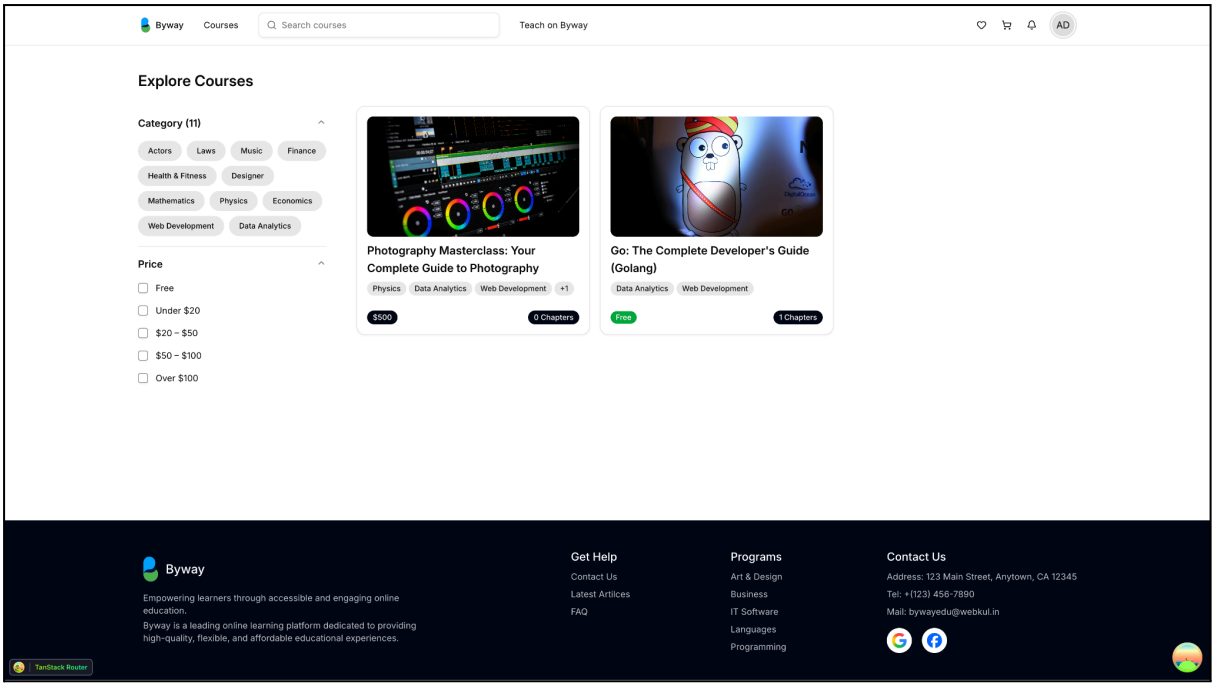


Figure 4.7. Explore courses

2.3. Admin dashboard

Admin is allowed to manage the users, categories and process the requests from users (students) and instructors.

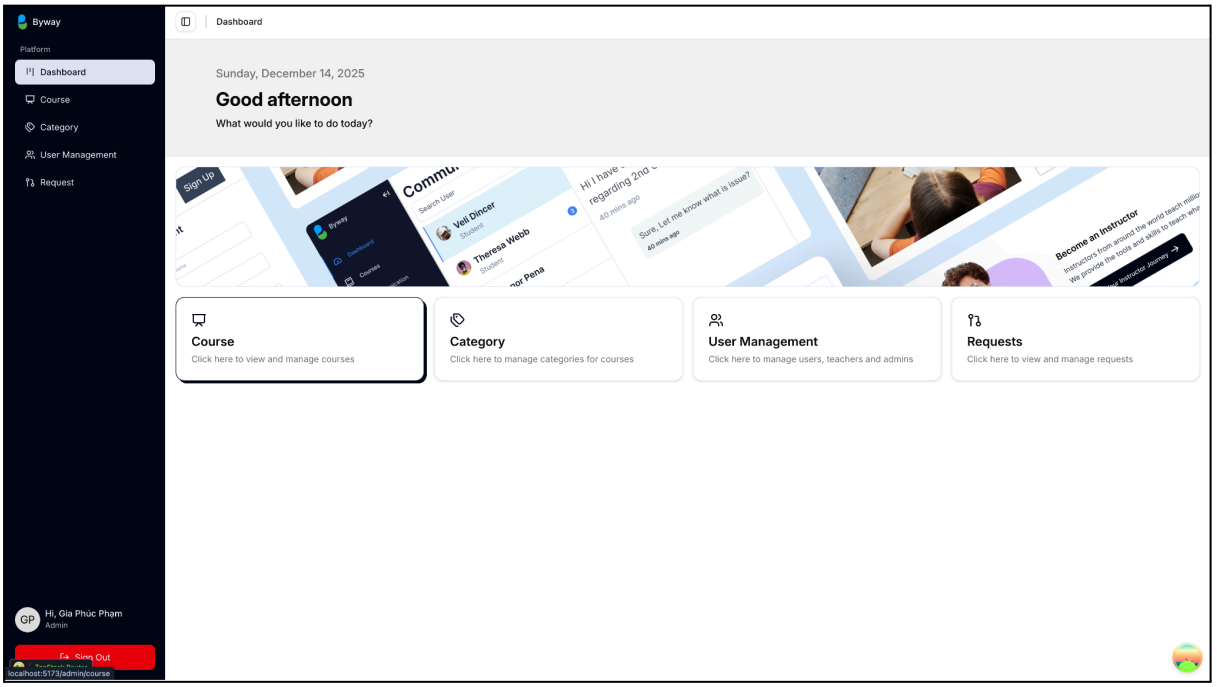


Figure 4.8. Dashboard page

In the category section, an admin can view a list of categories. They can click to create, edit or delete a category and select multiple categories to delete many.

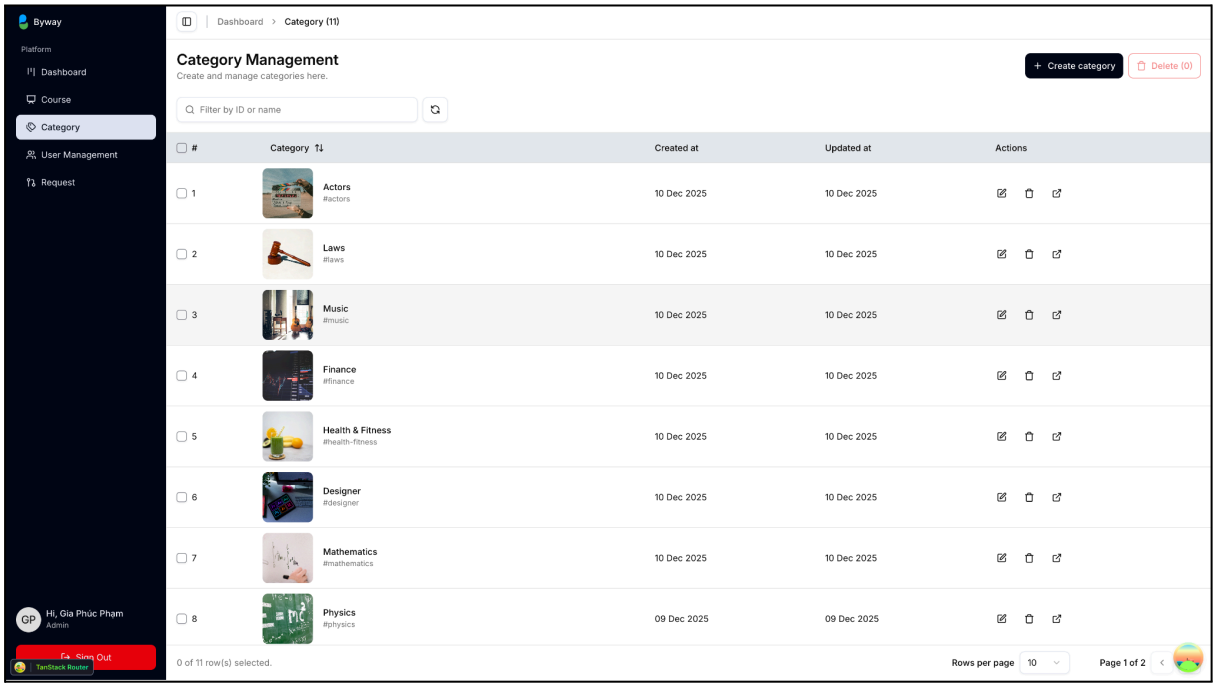


Figure 4.9. Category section

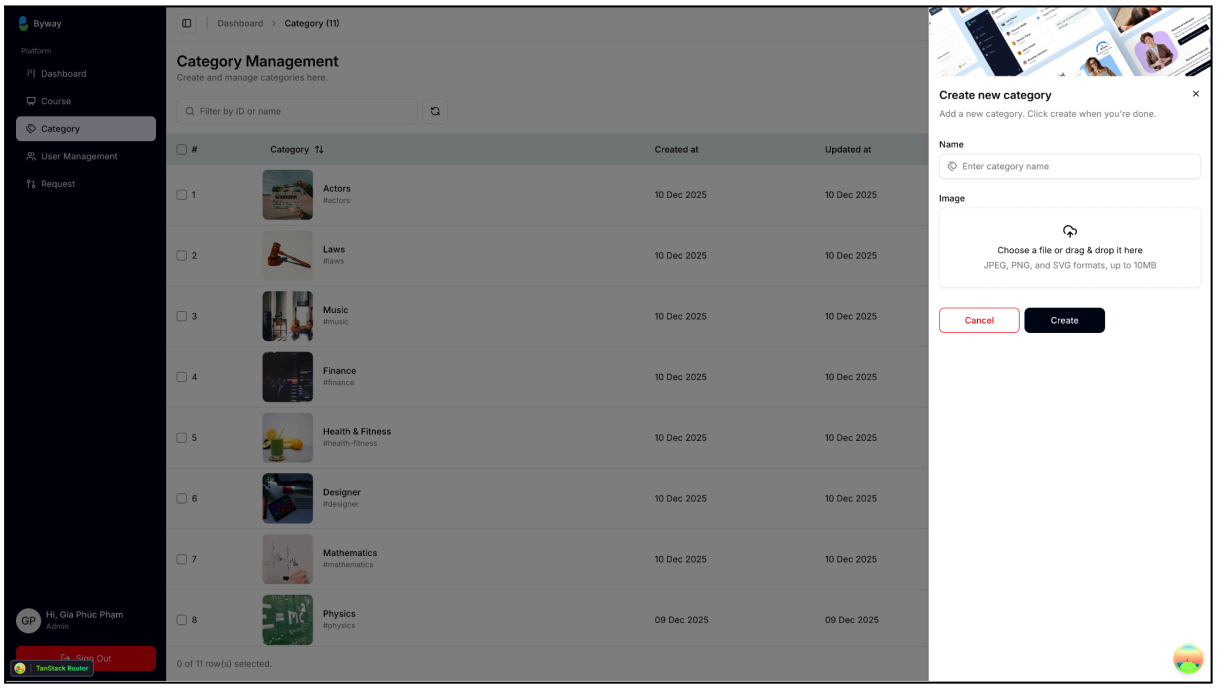


Figure 4.10. Add new category

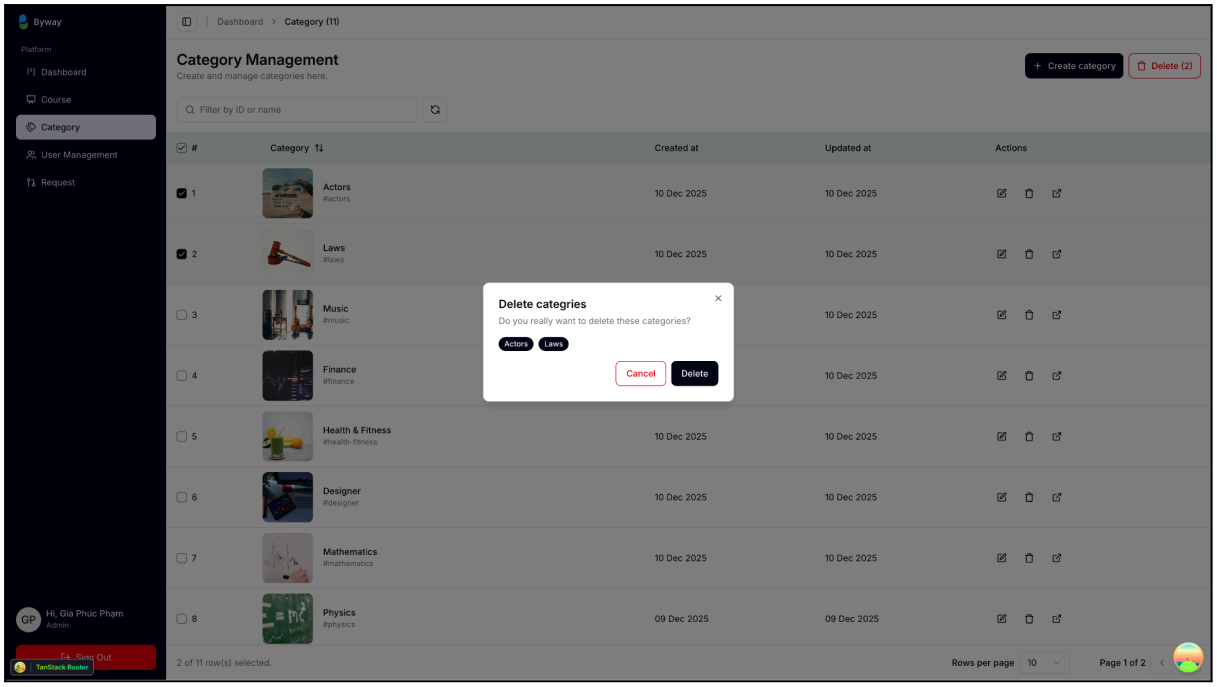
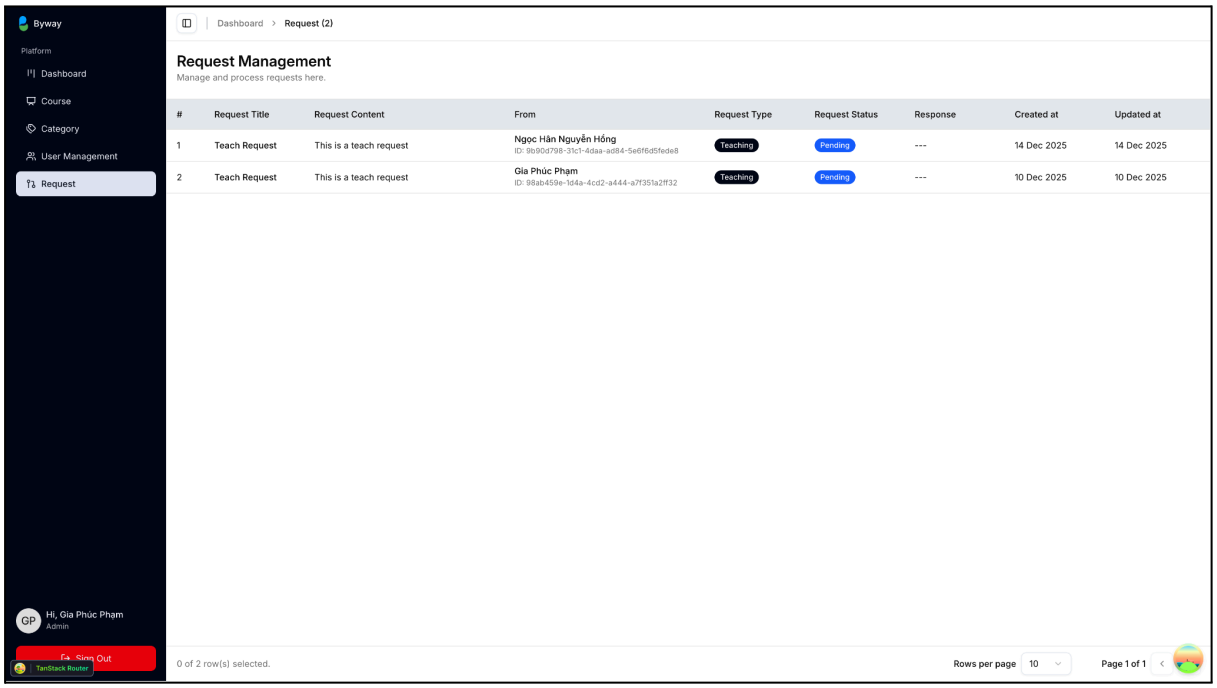


Figure 4.11. Delete multiple categories

In the request section, an admin can process the requests (category or teaching requests) from the users. The list of requests is shown in a table format.



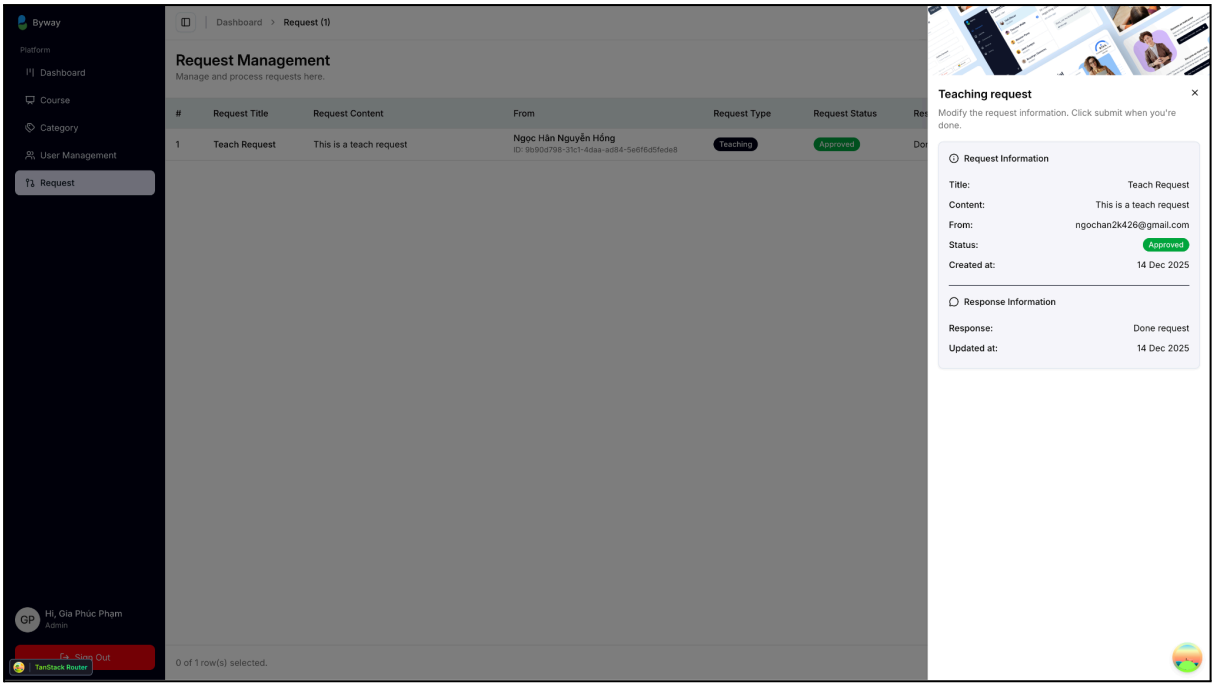


Figure 4.12. Request section

2.4. Instructor section

Instructors can manage and create courses with chapters and lessons. Beside that, they can view their students and reviews.

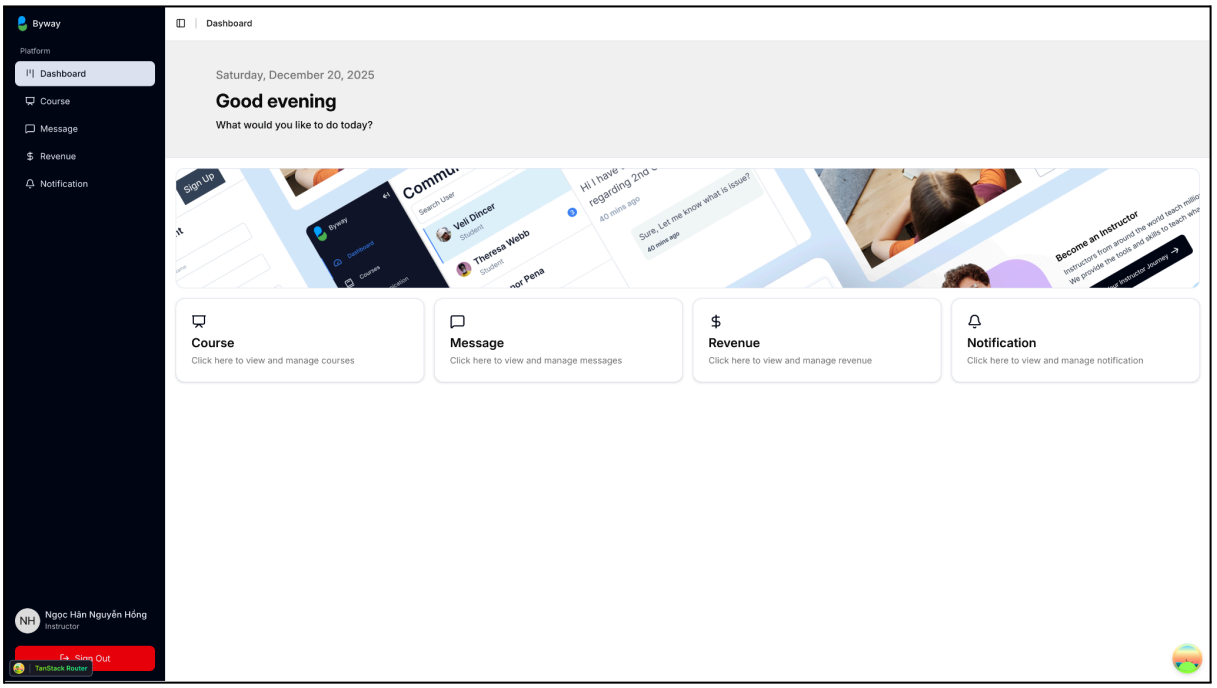


Figure 4.13. Instructor dashboard

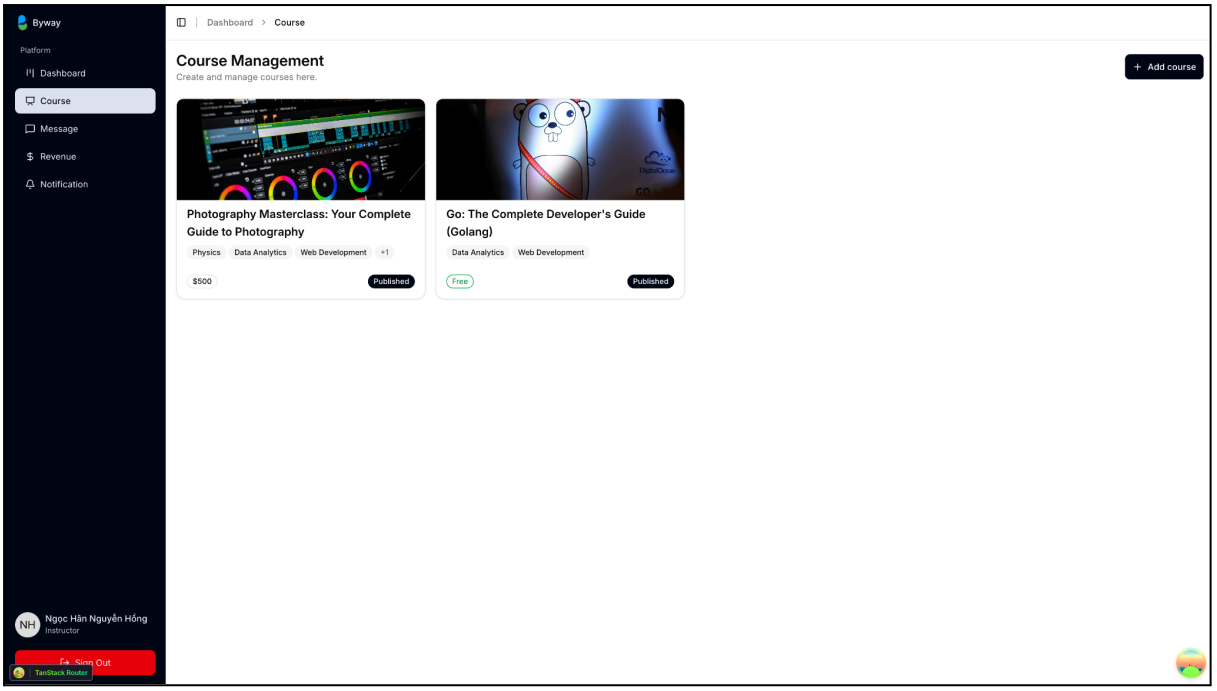


Figure 4.14. View instructor's courses

Figure 4.15. Create new course

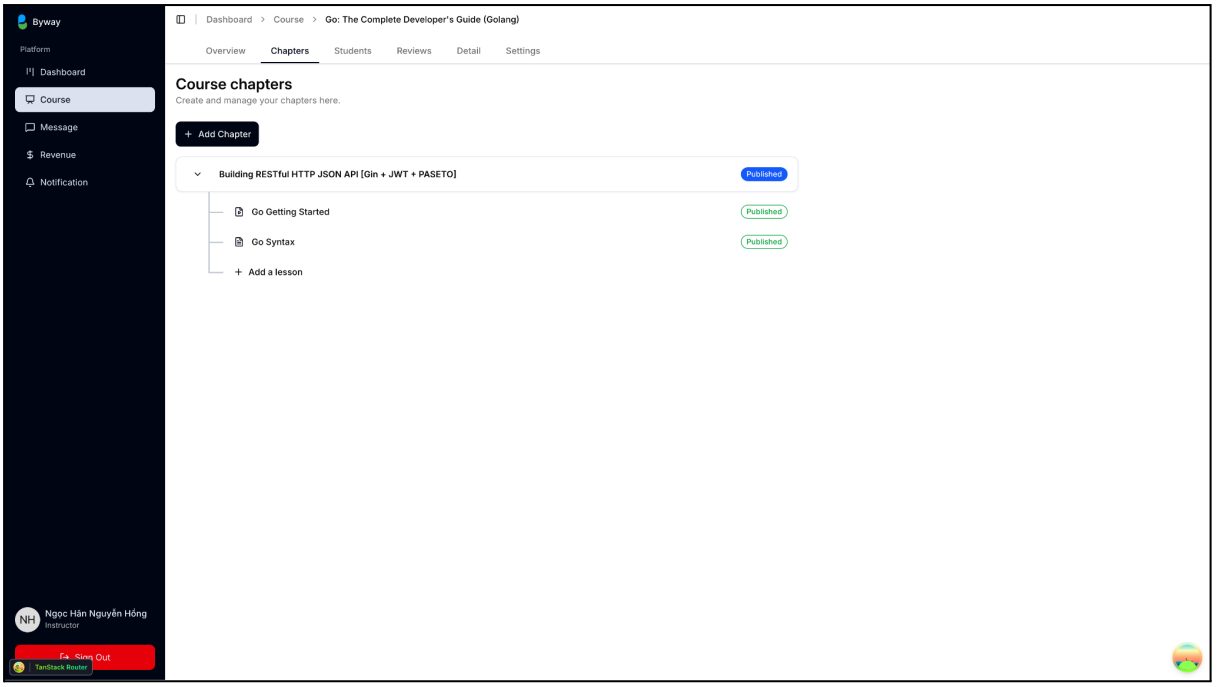


Figure 4.16. View chapters of course

Figure 4.17. Add a lesson

2.5. Student section

Students can search and enroll in the courses they want to learn. Byway provides a friendly user interface like the text editor and modules tree list to help the student easier to learn the lectures. The student can also track the progress of their

courses while they are learning. Moreover, if the student want to become an instructor they can request a teaching permission from the Byway's admin

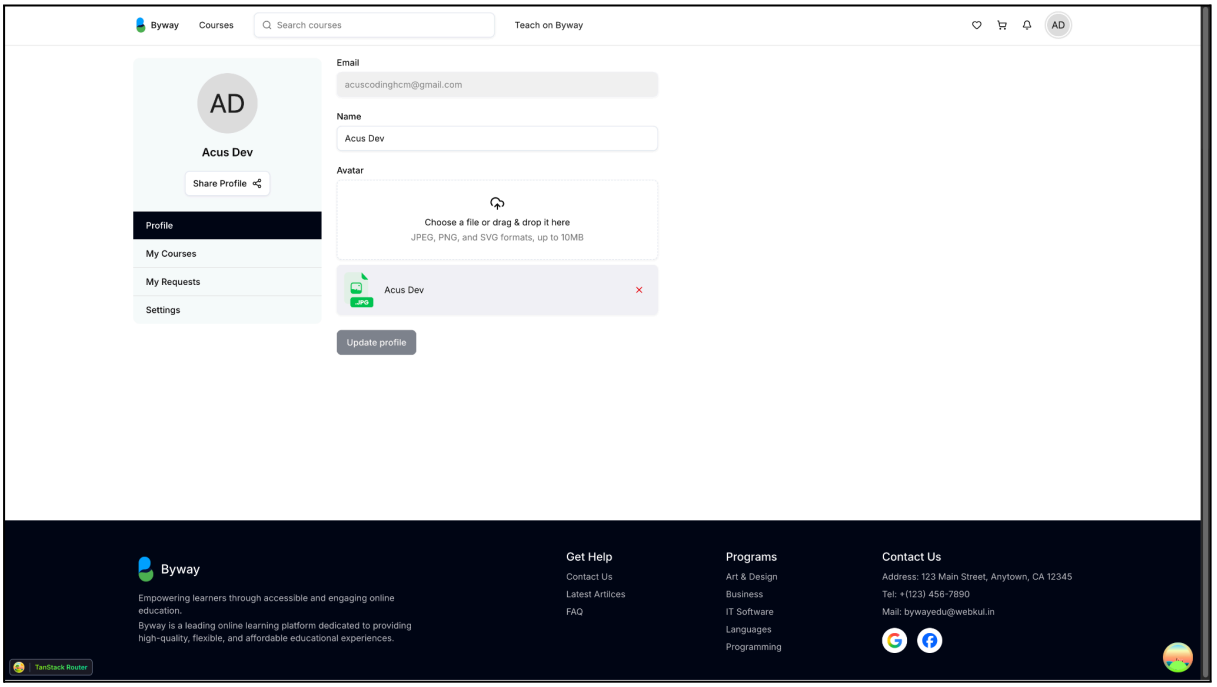


Figure 4.18. User profile

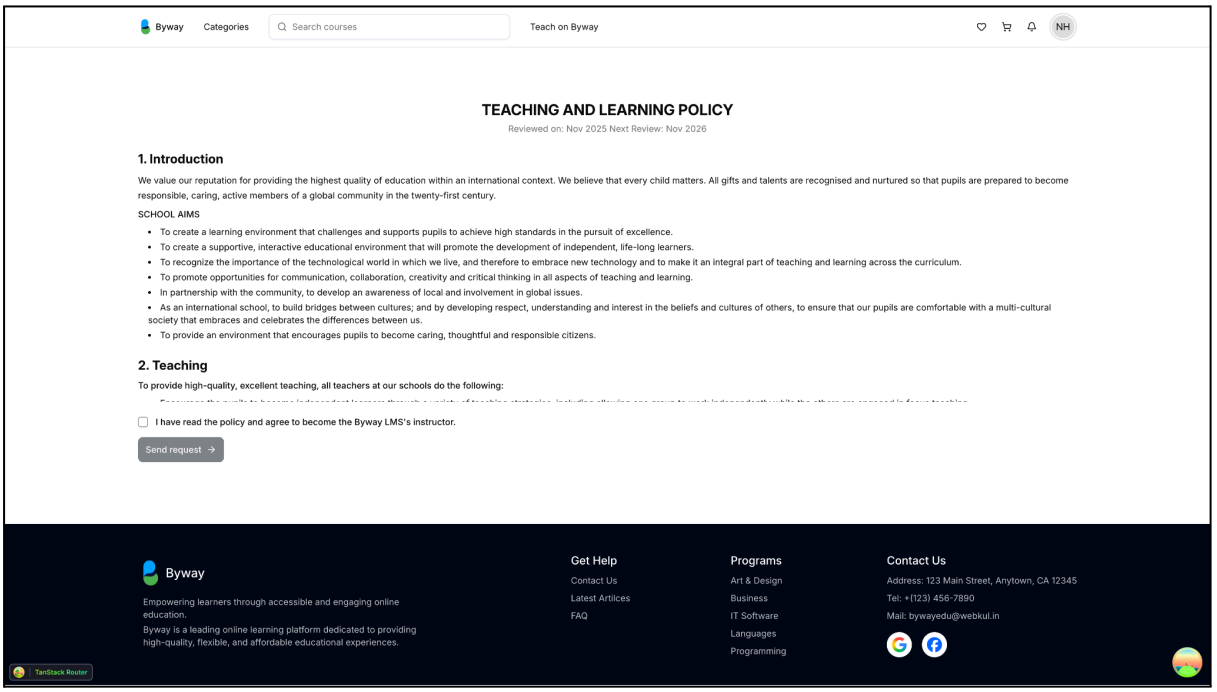


Figure 4.19. Teaching and learning policy

3. Testing

3.1. User Authentication & Authorization

Table 4.20. Test case 1 for User Authentication & Authorization

Test Case #: UAA_01	**Test Case Name:** User sign up with email verification
	Subsystem: User Authentication & Authorization
System: Byway LMS	**Design Date:** 25/11/2025
	Execution Date: 01/12/2025
Designed by: Gia Phúc	
Executed by: Ngọc Hân	
Short Description: Test the user's account registration with valid information.	

Preconditions:
The email used for registration does not exist in the system database.

Step	Action	Expected System Response	Pass/Fail	Comments
1	Navigate to the "Sign Up" page.	The system displays the sign-up form with input fields and role selection for role Student/Teacher.	**Pass**	
2	Enter valid details in required fields	The system checks the email format, email existence and password convention (at least 6 characters, including numbers).	**Pass**	
3	Click the "Sign up" button.	The system sends a verification OTP to the registered email and redirects the user to the verification page.	**Pass**	

4	Open the registered email and check for the OTP code.	The verification OTP code is sent successfully.	**Pass**	
5	Back to the Sign up page and enter the verification OTP in the required field.	The system activates the user account and displays a confirmation message. The user is redirected to the Homepage.	**Pass**	
6	Repeat from step 2 but with an already registered email address.	The system displays an error message showing that this email is already registered, and prompts the user to log in or use a different email address.	**Pass**	

Postconditions

- Happy path: A new user account is created with the provided email address and password in the system database. The user successfully logs in and is navigated to the Homepage.
- Edge case: System displays unsuccessful message, user stays in Sign up page for another attempt.

Table 4.21. Test case 2 for User Authentication & Authorization

Test Case #: UAA_02	**Test Case Name:** User login with account
System: Byway LMS	**Subsystem:** User Authentication & Authorization
	Design Date: 25/11/2025
Designed by: Gia Phúc	**Execution Date:** 01/12/2025
Executed by: Ngọc Hân	
Short Description: Test user login with valid credentials.	

Preconditions

The user has a valid account with the registered email and password.

Step	Action	Expected System Response	Pass/Fail	Comments
1	Navigate to the "Log in" page.	The login form is displayed with fields for username/email and password.	**Pass**	
2	Fill the email/username and password into appropriate fields.	The system validates the entered credentials and activates the “Sign in” button.	**Pass**	
3	Click the “Sign in” button.	The system verifies the account and redirects the user to the Homepage.	**Pass**	
4	Repeat step 2 with an invalid email or password format.	These fields are highlighted with red color to notify that email or password is not in correct format.	**Pass**	
5	Repeat steps 2,3 with a non-registered email or the wrong password.	The system replies with the wrong account and then prompts the user to check the information again.	**Pass**	

Postconditions - Happy path: The user is logged in and has access to their account. A user session is created in the system. - Edge case: The user remains on the login page with an error message.

3.2. Course Management

Table 4.22. Test case 1 for Course Management

Test Case #: CM_01	**Test Case Name:** Display Course
System: Byway LMS	**Subsystem:** Course Management
Designed by: Gia Phúc	**Design Date:** 26/11/2025
Executed by: Viễn Phát	**Execution Date:** 01/12/2025
Short Description: Test that the user can view courses and access restricted content like course modules, and course lessons after logging in.	

Preconditions:
The user is logged in with a valid account.
The system stores available courses with contents.

Step	Action	Expected System Response	Pass/Fail	Comments
1	Navigate to the Homepage.	The homepage is displayed with many recommended courses.	**Pass**	
2	Click on a specific course.	The system displays the course page with general information and course content.	**Pass**	
3	Attempt to enroll for the course by clicking the "Join the class" button.	The system activates the enrollment process.	**Pass**	
4	Enroll in the course.	The user is successfully enrolled in the course, and the system shows a confirmation message.	**Pass**	

5	Check the course progress after enrolling in a course.	The system displays the correct course progress and marks lessons as completed when the user has completed them.	**Pass**	

Postconditions The logged-in user can view all course details and can enrol in new courses. The logged-in user can keep track of the course learning progress.

Table 4.23. Test case 3 for Course Management

Test Case #: CM_04	**Test Case Name:** Enroll Course
System: Byway LMS	**Subsystem:** Course Management
Designed by: Gia Phúc	**Design Date:** 26/11/2025
Executed by: Viễn Phát	**Execution Date:** 01/12/2025
Short Description: Test the enrollment process for a course with a Student role.	

Preconditions: The user is logged in with valid credentials. The course must be available for enrollment and not already be enrolled by the user.

Step	Action	Expected System Response	Pass/Fail	Comments
1	Navigate to the course detail page.	The system displays the course details page, including the "Join the course" button.	**Pass**	
3	Click the “Join the course” button.	The system processes the enrollment.	**Pass**	
	Check the user’s course page “My	The newly enrolled course appears in the "My Courses"	**Pass**	

	Course".	section.		
4	Attempt to access course content (video lesson, text lesson).	The system allows the user to access the course content.	**Pass**	

Postconditions
The user is successfully enrolled in the course and can access course content. The course appears in the "My Course" section in the "In Progress" tag.

Table 4.24. Test case 4 for Course Management

Test Case #: CM_05	**Test Case Name:** Instructor Creates Course
System: Byway LMS	**Subsystem:** Course Management
Designed by: Gia Phúc	**Design Date:** 26/11/2025
Executed by: Ngọc Hân	**Execution Date:** 01/12/2025
Short Description: Test the process of creating a new course by an instructor, modules, and lessons by an instructor.	

Preconditions:
The user is logged in as an Instructor. Required resources like course templates and storage should be available.

Step	Action	Expected System Response	Pass/Fail	Comments
1	Log in to the platform with an instructor account.	The user is authenticated and redirected to the Homepage.	**Pass**	
2	Navigate to the "My Course" section.	The course management page is displayed.	**Pass**	

3	Click on the “Add new course” button.	The system displays an “Add new course” form with fields for the course’s name and description.	**Pass**	
4	Fill in the course name and description.	The system validates the inputs for any required fields and formats.	**Pass**	
5	Click the “Add course” button to continue.	The system assigns the course with a unique identifier and proceeds with the creation process.	**Pass**	
6	Select the level (Beginner, Intermediate, Advanced)	The system shows the multiple choice form for the user to select the corresponding level.	**Pass**	
7	Upload course thumbnails.	The system allows the instructor to upload the image and validates the file type/size.	**Pass**	
8	In the “Course content” section, click the “Add new section” and enter the module title (e.g., "Chapter 1: Introduction").	The system saves the module in the course but does not require detailed content at this point.	**Pass**	
9	Repeat step 8 to add multiple modules to the course (e.g., "Chapter 2: Variables and Methods").	The system adds each module with its respective titles and descriptions under the course page.	**Pass**	

10	Click the “Edit” button in a specific module to edit it.	Navigate to the Course Module management page within the newly created course.	**Pass**	
11	Modify the module details (change the title or update the module description).	The system saves the updated module details and reflects them on the course page.	**Pass**	
12	In the “Lesson” section, click “Add new lesson” and enter the lesson title.	The system validates the lesson details and saves the new lesson within the module.	**Pass**	
13	Repeat step 12 to add multiple lessons to the course module.	The system adds each lesson with its respective titles and descriptions under the course module page.	**Pass**	
14	Click the “Edit lesson” button in a specific lesson tag to edit it.	Navigate to the Lesson Creation management page.	**Pass**	
15	Edit the description and upload the video lesson.	The system allows the instructor to upload materials and validates the file type/size.	**Pass**	
16	Click "Save" to complete the process.	The system confirms that the course has been created successfully; saves new courses to the instructor’s course management page; gives availability to the course.	**Pass**	

Postconditions

The courses, modules, and lessons are successfully created and saved in the system. The course can be found on Homepage and is available for students to view and enrol in.

CHAPTER 5: CONCLUSION & FUTURE WORK

1. Conclusion

Overall, the Byway Learning Management System (LMS) project was carried out over a period of 2 months by a development team consisting of three members. This section presents a comprehensive discussion of the project outcomes and implementation approach.

The Byway LMS was designed and developed following the Waterfall development model. This approach was selected because the project scope was relatively small and the system requirements were clearly defined with minimal expected changes. In addition, limited direct interaction with stakeholders made Agile methodologies less appropriate. At the early stages of development, internal training sessions were organized to help team members who were unfamiliar with the chosen technologies, while other project phases progressed in parallel to maintain the overall timeline.

Regarding project management and collaboration, all meetings and discussions were conducted through Discord, ensuring effective real-time communication. Google Drive was used for sharing documentation and development resources, while Google Sheets supported task tracking and progress monitoring. These tools were chosen for their comprehensive features, ease of use, and cost-effectiveness, aligning well with the project's budget constraints.

2. Contribution

Table 5.1. Contribution table

Name	Role	Contribution
Phạm Gia Phúc	Leader + Fullstack developer	33%
Nguyễn Hồng Ngọc Hân	Reporter + Backend developer	33%
Lê Viễn Phát	Frontend developer	33%

3. Future works

Although the Byway Learning Management System successfully fulfills its core objectives, several enhancements can be considered for future development to further improve functionality, scalability, and user experience.

Future work may include the integration of real-time communication features, such as live video classes or virtual classrooms, to support synchronous learning. Additionally, incorporating advanced analytics and reporting tools would enable instructors and administrators to gain deeper insights into learner performance, engagement levels, and course effectiveness.

The system can also be extended by adding mobile application support to provide a more seamless learning experience across smartphones and tablets. Implementing AI-driven features, such as personalized course recommendations and automated assessment feedback, could further enhance learning outcomes.

From a system perspective, future improvements may involve strengthening security mechanisms, optimizing database performance, and supporting scalability to accommodate a larger number of users. Integration with third-party tools such as payment gateways, certification services, or external learning resources could also broaden the platform's usability.

By addressing these potential enhancements, Byway LMS can evolve into a more comprehensive and adaptive learning platform that meets the growing demands of modern online education.