TRIBHUVAN UNIVERSITY

FACULTY OF HUMANITIES AND SOCIAL SCIENCES

LALITPUR ENGINEERING COLLEGE

LABXPLORER: INTERACTIVE LEARNING ENVIRONMENT

BY

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A PROJECT PROPOSAL

SUBMITTED TO THE DEPARTMENT OF COMPUTER APPLICATION

IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR

THE DEGREE OF BACHELORS IN COMPUTER APPLICATION

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Submitted to

Department of Computer Application

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In partial fulfillment of the requirement for the degree of Bachelors in Computer Application

Submitted by

Sushant Bramhacharya (LEC077BCA08)

JUNE, 2024

Under the Coordination of

Er. Bibat Thokar

DECLARATION

I declare that the work hereby submitted for Bachelors in Computer Application at the Department of Computer Application , Lalitpur Engineering College entitled "**LabXplorer: Interactive Learning Environment**" is my own work and has not been previously submitted by me at any university for any academic award. I authorize the Department of Computer Application , Lalitpur Engineering College to lend this project work to other institutions or individuals for the purpose of scholarly research.

Sushant Bramhacharya (LEC077BCA08)

June, 2024

RECOMMENDATION

The undersigned certify that they have read and recommend to the Department of Computer Application for acceptance, a project work entitled "**LabXplorer: Interactive Learning Environment**", submitted by **Sushant Bramhacharya (LEC077BCA08)** in partial fulfillment of the requirement for the award of the degree of "**Bachelors in Computer Application**".

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June, 2024

DEPARTMENTAL ACCEPTANCE

The project work entitled "**LabXplorer: Interactive Learning Environment**", submitted by **Sushant Bramhacharya (LEC077BCA08)** in partial fulfillment of the requirement for the award of the degree of "**Bachelors of Computer Application**" has been accepted as a genuine record of work independently carried out by the student in the department.

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Sushant Bramhacharya (LEC077BCA08)

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ABSTRACT

LabXplorer is an innovative web application that will be developed using React, Express, and Postgres, designed to revolutionize science education by providing interactive virtual experiments. This platform offers a user-friendly interface where students can conduct various experiments, track their progress, and showcase their scientific achievements. By leveraging real-time, visually engaging simulations powered by Phaser.js, LabXplorer enhances students' understanding of scientific concepts through hands-on learning. The platform also supports collaboration and knowledge sharing via integrated discussion forums and messaging systems, fostering a community of inquisitive learners. Comprehensive feasibility studies, addressing technical, operational, and economic aspects, along with detailed system design diagrams, ensure the platform's robustness and scalability. Utilizing the latest cross-platform development technologies, LabXplorer delivers a responsive and efficient user experience. Rigorous unit testing, particularly on the authentication module, ensures security and reliability, making LabXplorer a dynamic, effective, and engaging tool for modern science education.

Keywords: *Interactive, Collaboration, Simulation*

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LIST OF ABBREVIATIONS

ACID	Atomicity, Consistency, Isolation, Durability
DFD	Data Flow Diagram
ER	Entity-Relationship
IT	Information Technology
JS	JavaScript
OS	Operating System
SQL	Structured Query Language
UI	User Interface
UX	User Experience

1 INTRODUCTION

1.1 Introduction

LabXplorer revolutionizes science education by providing an innovative virtual laboratory platform designed to transcend traditional learning methods. Tailored specifically for students and educators in STEM fields, LabXplorer aims to bridge gaps in practical science education by offering interactive simulations and experiments across diverse disciplines. This cutting-edge platform serves as a dedicated arena where learners can engage deeply with scientific concepts, conduct virtual experiments, visualize data, and collaborate seamlessly within their academic community.

1.2 Problem Statement

LabXplorer addresses critical gaps in science education by providing a dedicated platform specifically designed for virtual laboratory experiences. Unlike general educational platforms that lack interactive laboratory components, LabXplorer offers tailored modules such as Basic Electronics Lab, Basic Chemistry Lab, Basic Astronomy Simulations, and a Basic Online Coding Environment with animations. This specialized approach enables students to gain hands-on experience and apply theoretical knowledge in practical settings, enhancing their understanding and retention of scientific concepts. For educators, LabXplorer provides tools to perform simulations, create experiment workflows, assign tasks to students, and facilitate collaborative learning through a discussion forum. By integrating various scientific disciplines into a unified virtual laboratory environment, LabXplorer streamlines the learning process and supports deeper engagement with subject matter. This platform is particularly valuable for schools and institutions with limited physical laboratory resources, ensuring all students have access to high-quality educational experiences regardless of their location or infrastructure constraints.

1.3 Objectives

- Create a virtual laboratory platform that enhances science education through interactive simulations and experiments across various disciplines.

1.4 Scope

- The platform should provide a virtual space for students and educators to conduct interactive simulations and experiments across various scientific disciplines.
- LabXplorer should facilitate collaborative learning through discussion forums enabling students to share insights and ask questions.
- The platform should be user-friendly and accessible, making it easy for students of all levels to engage in virtual laboratory activities.

1.5 Report Organisation

The material in this project report is organised into seven chapters. After this introductory chapter introduces the problem topic this project tries to address, chapter 2 contains the literature review of vital and relevant publications, pointing toward a notable research gap. Chapter 3 describes the methodology for the implementation of this project. Chapter 4 provides an overview of what implementation tools are used. Chapter 5 contains Conclusion and Expected Outcomes of the project.

2 BACKGROUND AND LITERATURE REVIEW

2.1 Background Study

We are looking for designs that make out system visually appealing and at the same time have better performance. As this system is mainly for creatives who can share their journey, we need to implement a profile system that shows off their portfolio and resume. Showcasing their skills should be easy so this system mainly focuses on functionalities implementations. We are looking for different tools and techniques for achieving those goals. We are also studying papers, articles, and related books for our project. We are also learning about implementation about messaging system. The proposed project is to create an app for creative it professionals where they can share their discussions, projects, skills, and perform messaging functions. To develop this app, it is important to understand code collaboration, tools for code sharing, and messaging functions.

2.2 Limitation

- Graphics are planned to designed by myself can reduce in quality and become time consuming.
- We cannot message through our system directly.

2.3 Literature Review

Teacher perception of Olabs pedagogy

OLabs, as name says, offers a robust web-based platform encompassing simulations, animations, tutorials, and assessments, designed to enhance interactive and accessible learning experiences outside traditional laboratory settings. Emphasizing student-centered learning, inquiry-based approaches foster essential skills such as scientific thinking, evidence-based reasoning, and creative problem-solving, which are fundamental for knowledge creation and retention.[1]

How Khan Academy is changing the rules of education

This paper briefly describes how can an online learning platfrom change the way our education system worka and improve on it.

- Khan Academy offers free, online instructional videos covering various subjects, allowing students to learn at their own pace and revisit concepts.
- The platform uses analytics to provide real-time feedback, enhancing personalized learning experiences for both teachers and students.
- Khan Academy promotes a flipped classroom model where students watch videos at home and engage in problem-solving and discussions in class, fostering deeper understanding and collaboration.
- It democratizes education by providing high-quality instruction globally, irrespective of geographic location or socioeconomic status.
- The platform challenges traditional educational paradigms and suggests new possibilities for delivering effective education in the digital era.

Khan Acadamy being one of the main motivation for onile learning and educating. [2]

PhET: Interactive simulations for teaching and learning physics

Perkins et al. (2006) introduce PhET, a collection of interactive simulations designed to enhance the teaching and learning of physics. These simulations aim to make abstract concepts more accessible and understandable through dynamic visualizations and interactive models. The authors emphasize the effectiveness of PhET in promoting conceptual understanding by allowing students to manipulate variables and observe real-time outcomes, thereby bridging the gap between theoretical concepts and practical application. They discuss the development process, which involves collaboration between physicists, educators, and software developers to ensure accuracy and educational efficacy. The article highlights PhET's versatility in catering to diverse learning styles and educational settings, promoting active learning and engagement. [3]

An Introduction to HTML5 Game Development with Phaser.js

It provides a comprehensive guide to creating 2D games using the Phaser.js framework. It covers setting up a development environment, understanding fundamental game concepts, and managing game states and assets. The book teaches how to implement physics and collision detection, create animations and visual effects, design user interfaces, and integrate audio. It emphasizes practical, project-based learning, guiding readers through real game development scenarios. Additionally, it offers debugging, optimization techniques, and deployment strategies for various platforms, making it an essential resource for both beginners and experienced developers looking to master HTML5 game development with Phaser.js.[4]

3 METHODOLOGY

3.1 System Development Approach

An incremental approach, also known as an iterative or step-by-step approach, is a development or problem-solving method that breaks down a larger task or project into smaller, manageable increments or steps. Rather than attempting to tackle the entire task at once, an incremental approach focuses on making incremental progress by completing and delivering smaller portions of work in a series of iterations.

- Initial Planning and Requirements Gathering
- Increment Planning and Design
- Development and Implementation
- Testing and Quality Assurance
- Evaluation and Feedback
- Iterative Development and Refinement
- Deployment and Release
- Repeat the Process for Subsequent Increments

3.2 Requirement Analysis

3.2.1 Functional Requirements

The functional requirements of LabXplorer are mentioned below:

- **User Profiles and Progress Tracking:** LabXplorer allows children and teachers to create personalized profiles to track their progress and achievements. Users can log in with unique credentials, update profiles with educational interests and avatars, and monitor completion of experiments and simulations. Progress tracking includes recording tasks completed, concepts learned, and unlocking achievements, providing a comprehensive overview of individual learning journeys.

- **Interactive Virtual Laboratories:** LabXplorer features interactive virtual labs including Basic Electronics, Basic Chemistry, Basic Astronomy, and an online Coding Environment. These labs offer immersive simulations where users engage in hands-on activities like experiments and equipment manipulation. Through interactive animations and real-world scenarios, LabXplorer facilitates experiential learning, enabling exploration of scientific principles and phenomena in a dynamic digital environment.

- **Teacher Tools and Student Assignments:** Teachers access specialized tools to create experiment workflows and assign tasks to students. Experiment workflows can be customized with sequential steps, interactive assessments, and checkpoints to monitor student progress. Teachers review completed tasks, provide feedback, and assess learning outcomes, fostering personalized learning experiences aligned with educational objectives and curriculum requirements.

- **Discussion Forum for Learning Community:** LabXplorer incorporates a discussion forum where users engage in collaborative learning and knowledge-sharing. Children and teachers initiate discussions, pose questions, share insights, and respond to peers' inquiries. The forum supports threaded discussions, tagging, and search features to facilitate meaningful interactions and peer-to-peer engagement.

- **Sandbox Mode for Creating Own Experiments:** LabXplorer includes a sandbox mode that allows users to create their own experiments. In this mode, students and teachers can design and conduct custom experiments using virtual tools and resources available in the platform. The sandbox environment supports creativity and exploration, enabling users to test hypotheses, simulate scenarios, and explore scientific concepts beyond predefined lab activities.

3.2.2 Nonfunctional Requirements

The nonfunctional requirements of LabXplorer are mentioned below:

- **Performance Enhancement:** The focus on performance involves optimizing the platform to handle high user loads and complex simulations efficiently. This includes minimizing reliance on external frameworks and ensuring smooth and responsive interactions.
- **Authentication Security:** Security is a paramount concern. To enhance the platform's security, advanced authentication algorithms, particularly focusing on hashing techniques within the backend environment, have been implemented. This ensures that user authentication data is stored and managed in a highly secure manner.
- **Better UX Design:** User experience is central to the project's success. The emphasis on better UX design means that every aspect of the platform's interface, from navigation to interaction, will be meticulously crafted to ensure a seamless and intuitive experience. This design approach caters not only to experienced users but also to newcomers, ensuring that all users can effortlessly navigate and engage with the platform.
- **Responsive Design:** Recognizing the diverse range of devices and browsers that users utilize, the creation of a responsive design is important for this project. This means that the platform's design and functionality will adapt flawlessly to various screen sizes, ensuring that users can access and interact with the platform effectively, whether they are using a desktop computer, tablet, or smartphone. This responsiveness guarantees a consistent and satisfying experience across different devices and platforms, promoting accessibility and usability.

3.3 Feasibility Analysis

A feasibility study is a systematic and structured analysis conducted to determine the viability and practicality of a proposed project plan. It serves as an evaluation tool

to assess whether the project can be successfully implemented and if it aligns with the organization's goals and objectives. It involves gathering and analyzing relevant information to determine if the project is technically feasible, operationally feasible, economically feasible, and scheduling feasible.

3.3.1 Economical Feasibility

Since the proposed system has a web application, we will be using free and open-source software development tools such as Flutter, Express, Postgres SQL. We will only need some economy for server for hosting.

3.3.2 Operational Feasibility

LabXplorer emphasizes operational feasibility through its user-centric approach, focusing on intuitive design and ease of use. The system is crafted to be highly interactive, allowing users, including students and educators, to navigate effortlessly without requiring extensive mobile app expertise. The user interface (UI) is designed with a clean layout and intuitive controls, ensuring a seamless experience for exploring features such as virtual experiments and educational resources. By minimizing training requirements and reducing potential user resistance, LabXplorer aims to enhance user acceptance and engagement. Overall, its intuitive design facilitates efficient utilization of the app's functionalities, supporting educational activities and fostering a positive user experience

3.3.3 Technical Feasibility

Combining Express.js with Flutter and PostgreSQL presents a technically feasible approach for developing a modern and scalable application. Express.js, built on Node.js, serves as a powerful backend framework ideal for creating RESTful APIs and managing server-side logic efficiently. PostgreSQL, known for its reliability and advanced features in data management, provides a robust foundation for storing and querying data securely. On the frontend, Flutter offers a unified framework for building responsive and visually appealing applications across multiple platforms using a single codebase. This combination leverages the strengths of each technology: Express.js for backend scalability and API development, PostgreSQL for robust data

handling, and Flutter for seamless cross-platform UI development. Supported by active communities and extensive documentation, this stack ensures technical support, resources, and flexibility for deployment and maintenance, making it well-suited for delivering modern, interactive applications.

3.4 High Level Design of System

3.4.1 Architecture Design

The following diagram shows diagram of our Architecture. Mainly shows what are the functions can be accessed after starting our application.

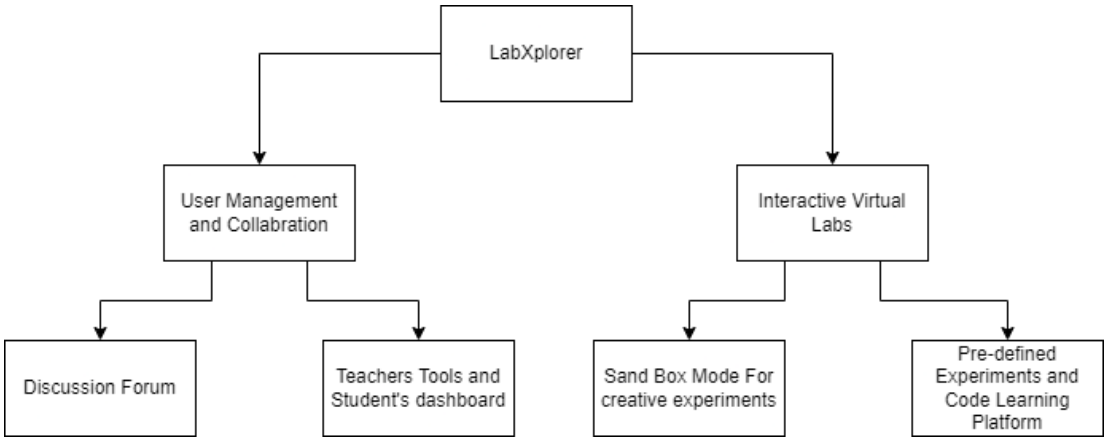

Figure 3.1: Main Architecture of System

3.4.2 Data Modelling(ER-Diagram)

ER Diagram is mainly used to design database schema. With the help of below er diagram we can easily design database in SQL.

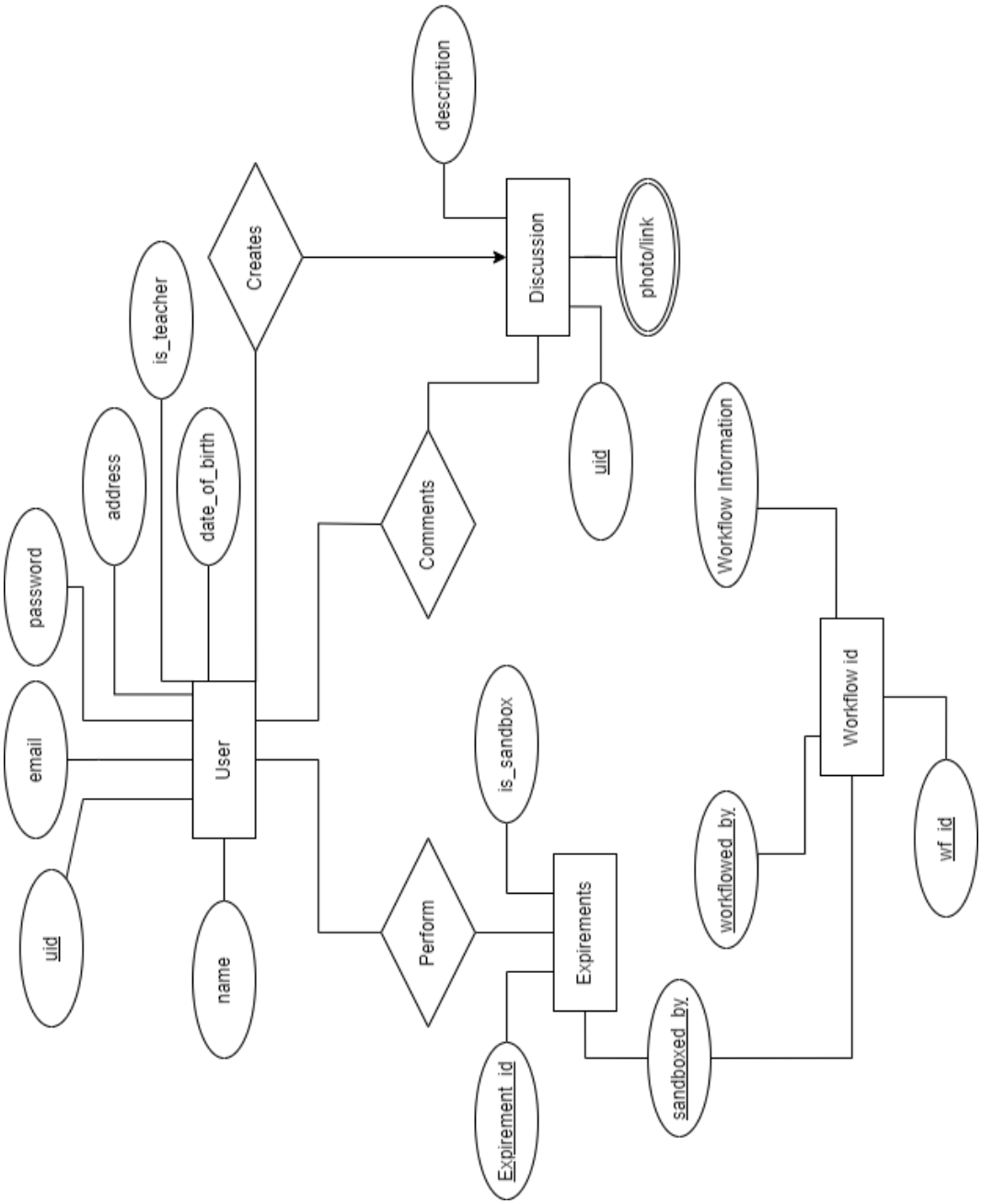

Figure 3.2: ER Diagram of System Data

3.4.3 Activity Diagram

An activity diagram visually presents a series of actions or flow of control in a system similar to a flowchart or a data flow diagram. This diagram showed how our program flow goes on.

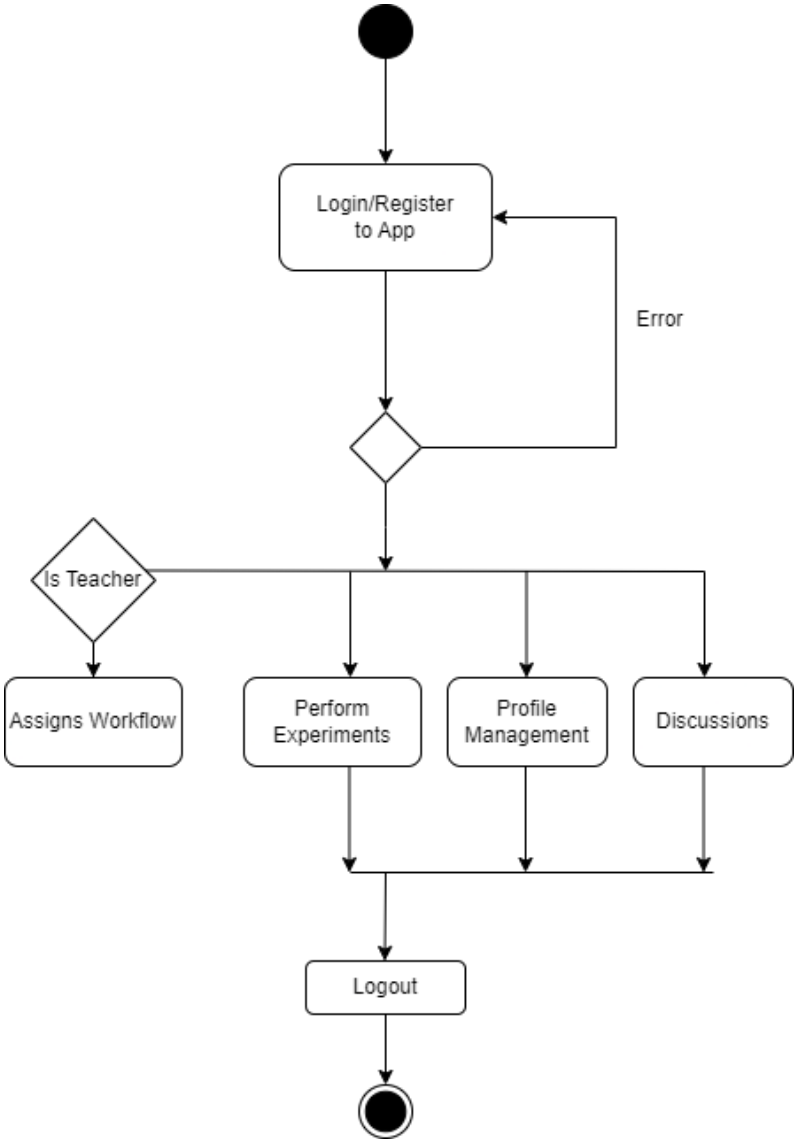

Figure 3.3: Activity Diagram

3.4.4 DFD

DFD or Data Flow Diagram is mainly used to show how data are being flowed in and out of our system. There are 3 levels of DFD i.e Context Level(Level 0),Level 1 and Level 2

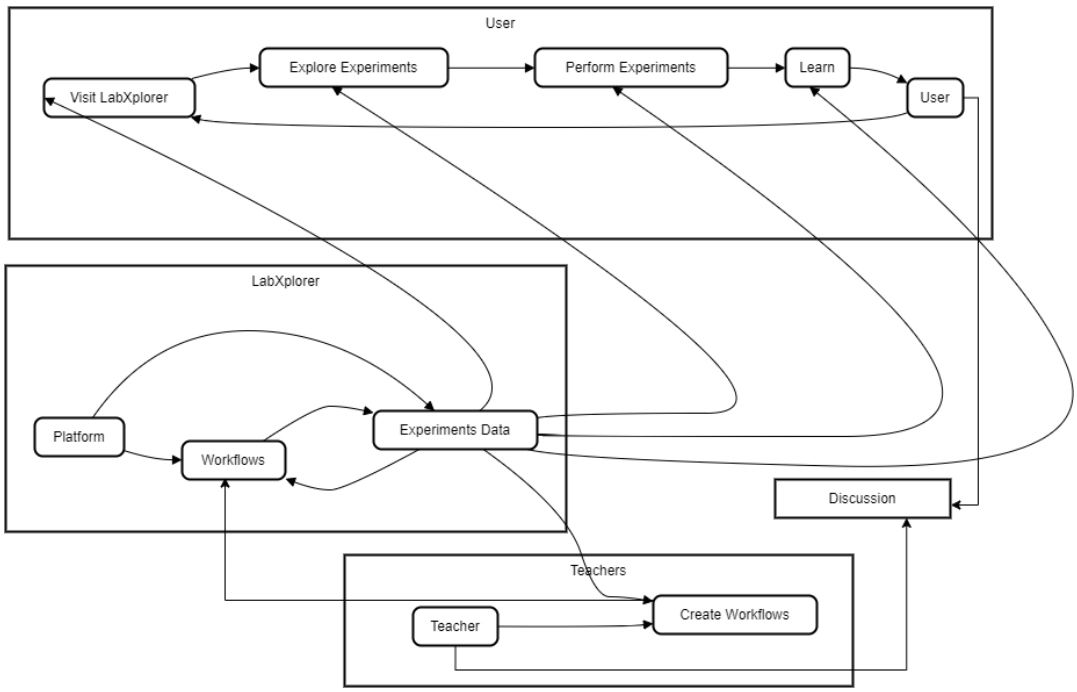

Figure 3.4: Data Flow Diagram (Context Level)

4 IMPLEMENTATION

4.1 Tools Used

Figma

Figma is a cloud-based design and prototyping tool that empowers teams to collaborate on UI/UX design projects in real-time. It offers a user-friendly interface and powerful features that make it a popular choice among designers. With Figma, designers can create and share interactive prototypes, design components, and design systems. Its cloud-based nature allows for seamless collaboration, enabling multiple team members to work on the same design simultaneously. Figma supports version control, ensuring that design iterations can be easily tracked and managed.

React

React is a widely-used open-source JavaScript library developed by Facebook for building user interfaces, particularly single-page applications where data changes frequently. It emphasizes a component-based architecture, allowing developers to create reusable UI components that encapsulate their own structure, logic, and styling. React's use of a virtual DOM enhances performance by minimizing direct updates to the real DOM, ensuring efficient rendering. With its declarative approach, developers specify what the UI should look like based on different states, making the code more predictable and easier to debug. Additionally, React introduces JSX, a syntax extension that combines JavaScript and HTML, making it straightforward to write and understand UI components.

Postgres

PostgreSQL, often referred to simply as Postgres, is a powerful open-source relational database management system known for its reliability, robustness, and extensibility. Developed over decades and maintained by a global community of contributors, PostgreSQL offers a comprehensive set of features for managing structured data. It supports complex queries, transactions with ACID (Atomicity, Consistency, Isolation, Durability) properties, and a wide range of data types including JSON, XML, and spatial data. PostgreSQL's commitment to standards compliance and continuous improvement ensures compatibility with various programming languages and

frameworks. With capabilities for scalability, data integrity, and advanced indexing, PostgreSQL is a preferred choice for applications requiring robust data management and high availability, contributing to its widespread adoption across industries from small startups to large enterprises.

Git/Github

Git is a distributed version control system that is both free and open-source, designed to handle projects of all sizes efficiently and swiftly. It simplifies collaboration by enabling multiple individuals to contribute changes that can be seamlessly merged into a single source. When using Git, the software runs locally on your computer, storing your files and their complete history. Alternatively, you can utilize online hosts like GitHub to store a copy of your files and their revision history. This central repository allows you to easily upload your changes and download updates from other developers, promoting seamless collaboration. Git facilitates automatic merging of changes, allowing multiple individuals to work on different sections of the same file and later merge their modifications without losing any work.

Node Js with Express

Node.js with Express.js is a powerful combination for building scalable and efficient web applications. Node.js provides a runtime environment that allows JavaScript to be executed server-side, leveraging its event-driven, non-blocking I/O model to handle multiple concurrent connections efficiently. Express.js, as a minimalist web framework for Node.js, simplifies the creation of APIs and routes, offering robust features such as middleware support, routing, and template engines. Together, Node.js and Express.js enable rapid development of RESTful APIs and web servers, making them well-suited for creating real-time applications, microservices, and backend systems. With a vibrant ecosystem of libraries and active community support, Node.js with Express.js remains a popular choice for developers seeking flexibility, performance, and scalability in web application development.

JavaScript

JavaScript is a programming language that is used to create interactive web pages and backend server. It is a powerful and versatile language that can be used to do a

wide variety of things, including adding animation and interactivity to web pages, validating form data, processing user input, making Ajax requests to the server, and creating games and other interactive applications.

Phaser

Phaser is a powerful and popular open-source HTML5 game framework designed for creating 2D games that can run in both web browsers and mobile environments. Developed by Photon Storm, Phaser is known for its versatility and ease of use, making it a favorite among both beginner and experienced game developers. The framework supports Canvas and WebGL rendering, automatically selecting the best option based on the device's capabilities. Phaser offers a robust set of features including physics engines (Arcade Physics, P2 Physics, and Matter.js), input handling, asset management, animations, and audio integration. Its component-based architecture allows developers to build complex games by combining reusable pieces of code, enhancing modularity and maintainability. With an active community, extensive documentation, and numerous tutorials, Phaser provides ample resources for learning and development, empowering creators to bring their game ideas to life efficiently.

5 CONCLUSION AND EXPECTED OUTCOMES

5.1 Conclusion

LabXplorer is an innovative virtual laboratory platform tailored for enhancing science education through interactive simulations and experiments. It aims to revolutionize how students and educators engage with scientific concepts by offering a diverse range of features. LabXplorer facilitates seamless exploration, collaboration, and learning across various scientific disciplines. This platform empowers users to conduct experiments, share insights, and leverage sophisticated algorithms to deepen their understanding. Additionally, LabXplorer integrates advanced reporting capabilities and decision-making tools, enriching the educational experience beyond traditional classroom settings.

5.2 Expected Outcome

LabXplorer aims to provide a transformative experience for students and educators in the realm of science education, addressing the challenges faced by newcomers and enthusiasts in navigating complex scientific concepts. By leveraging interactive simulations and experiments, LabXplorer offers an immersive platform where users can engage deeply with various scientific disciplines. It empowers students to conduct virtual experiments, explore theoretical concepts, and apply sophisticated algorithms, thereby enhancing their understanding and practical skills. LabXplorer also fosters collaborative learning environments where users can share insights, discuss findings, and collaborate on projects. Through this platform, newcomers gain valuable exposure to real-world applications of scientific principles and methodologies, bridging the gap between theoretical knowledge and practical implementation. By facilitating hands-on learning and access to comprehensive resources, LabXplorer endeavors to inspire curiosity, foster innovation, and prepare the next generation of scientists and researchers.

APPENDIX A

A.1 Project Schedule

Below is the Gantt chart of our project Schedule. We have planned to perfrom these specific tasks between these time frames.

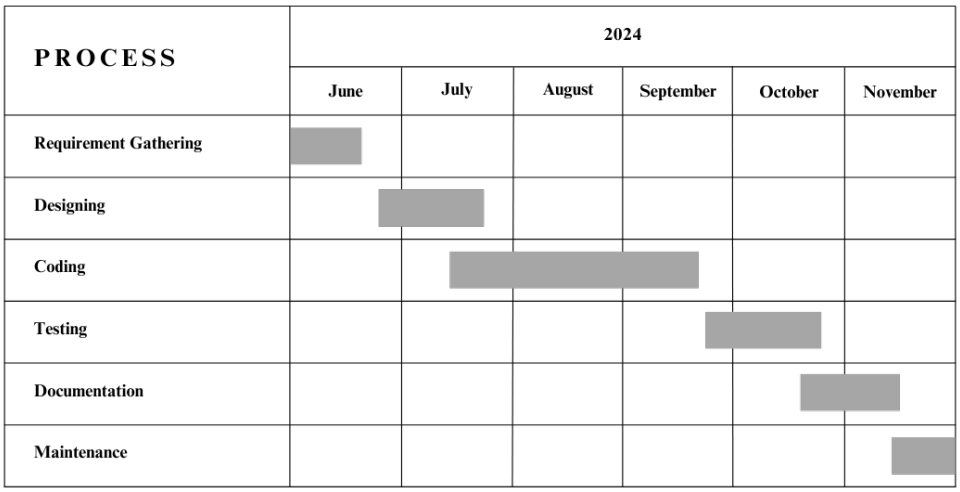

Figure A.1: Gantt Chart of Schedule

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