Journal of Economics, Business, and Government Challenges

Volume 6 Nomor 2 November 2023
DOI:
Page: 72-80

ISSN (Cetak): 1979-7117
ISSN(Online): 2614-4115

Development of a Project-Based Learning Monitoring Application for Programming Courses

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ARTICLE INFORMATION

Received: -

Revised: -

Accepted: -

Keywords: programming course, scrum framework, project management tools, learning platform.

ABSTRACT

In higher education programming courses, students often perform individual practical activities using their own devices, resulting in varying conditions and difficulty in ensuring proper application of the taught concepts. Limited access to equipment further hampers student progress. To address these challenges, implementing the Scrum framework in programming courses is proposed. Scrum offers problem-solving approaches emphasizing collaboration, self-organization, and cross-functional teams for effective teamwork and optimal solutions. However, existing project management tools like Trello and Notion, although free, have limitations when applied to Scrum. Trello lacks multi-sprint support, while Notion's complex customization features complicate usability. To overcome these limitations, this research aims to develop an application specifically tailored to Scrum practices. The objective is to design and create a comprehensive application that serves as both a learning platform and a project management tool. By leveraging this application, students will be able to enhance their learning experience and perform better project management, ensuring effective collaboration and communication among team members. The proposed application will address the limitations of existing tools and provide a seamless Scrum implementation within the programming course. Ultimately, the research seeks to improve the overall effectiveness and efficiency of programming education by empowering students with a robust and user-friendly platform that aligns with the Scrum framework.

INTRODUCTION

Teaching activities related to programming courses in the environment of the Faculty of Engineering, Surabaya State University, present several challenges in their implementation. Researchers perform duties at the Faculty of Engineering, Surabaya State University, as lecturers, one of whose tasks is to carry out teaching, especially in programming-related courses. During the execution of these duties, the researcher has conducted environmental scanning, where several issues have been identified as causes for the suboptimal progress in teaching programming courses. Some of the issues identified by the researcher include low student engagement, ineffective implementation, and difficulty in monitoring students' activities in programming course learning.

One of the challenges faced during the teaching and learning process in programming courses is that learning computer programming requires a significant amount of time but can also be learned individually (Al-Imamy, S., Alizadeh, J., and Nour, M. A., 2006), (Susanti, W. Et. al., 2021). The challenge lies in implementing programming skills, which are usually done through the creation of a final project, typically an application developed by a group over one semester. This project assignment is considered crucial in programming course learning because, in addition to fostering teamwork among students, it also facilitates faster development of programming skills through discussions among peers.

In the development of applications within a company, multiple individuals are typically involved, and communication among team members must be maintained. One approach to project management implemented in companies is the Scrum framework. Essentially, Scrum is a set of methods used to solve problems, including collaboration, self-organization within the team, and cross-functional teams (Morandini, M., Coleti, T. A., Oliveira, E., and Corrêa, P. L. P., 2021). It aims to make teamwork more effective and find the most appropriate solutions to the problems at hand. Scrum assists teams in problem-solving by promoting strong communication among team members (Hron, M. and Obwegeser, N., 2022). From a functional standpoint, this method can also be applied to the learning process in computer programming courses (Linden , T., 2018).

Before the pandemic, monitoring students' activities in programming courses could be done directly in computer laboratories by observing each student's computer. However, during the pandemic, direct monitoring of each student has been reduced, leading to suboptimal achievement of the expected technical skills in programming courses. It becomes challenging for instructors to ensure whether students are genuinely studying and practicing the programming materials being taught.

Practical exercises in programming courses are performed on individual devices, each with varying conditions. With this situation, it is difficult to ascertain whether students have practiced programming according to the given materials. Some students face obstacles due to limited equipment available to support their programming studies. Instructors find it challenging to monitor each student's laptop/computer to ensure they are practicing the learned programming language. The major assignments given to students are conducted in groups, and coordinating and documenting the task distribution among members has been a persistent challenge.

This research aims to develop a Project-Based Learning Management Application with the Scrum Framework for Programming Courses to support the teaching process in programming courses within the Faculty of Engineering, Surabaya State University. The application to be developed will be web-based, utilizing the Laravel framework and MySQL database.

LITERATURE REVIEW

Several previous studies have shown that the implementation of the Scrum framework in education has been done before and can be applied to support the learning process (Vogelzang, J., Admiraal, W. F., and Van Driel, J. H, 2020),(Rodriguez, G., Soria, Á., and Campo, M., 2015),(Fernandes, S., Dinis-Carvalho, J., and Ferreira-Oliveira, A. T., 2021). Essentially, the Scrum framework is a set of methods used to solve problems. Scrum itself adopts an approach from another method called Agile. Agile refers to a set

of methods and practices based on values and principles expressed in the Agile Manifesto (Hohl, P., et al., 2018). It includes aspects such as collaboration, self-organization within the team, and cross-functional teams. Considering its functions, this method is highly feasible to be implemented in the learning process of computer programming courses.

RESEARCH METHODS

The research method used is Research and Development (R&D), which focuses on the development of software. The aim is to design and develop a Project-Based Learning Management Application with the Scrum Framework for Programming Courses in the Environment of the Faculty of Engineering, Surabaya State University, based on a web platform. The research is expected to be completed within 6 months.

A. Research Flow

The research stages employed by the author in the application's development include problem identification, data collection, system analysis, system design, system development sprints, and system testing. A more detailed explanation can be found in the diagram shown in Figure 1.

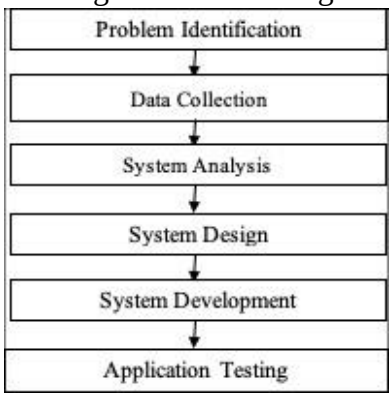

Fig. 1. Research Process

The data collection technique used in this research is through direct observation of the learning activities that have already implemented the Scrum framework but still rely on internet-based tools, specifically using Trello. Trello is available for free access; however, it still has limitations when it comes to implementing the Scrum method.

System analysis is conducted with the aim of determining what is needed to develop a website using the Scrum software development framework. It involves identifying the necessary adjustments to ensure that the resulting application is more suitable for supporting project-based learning in programming courses, making the learning process more effective and efficient.

System design is a stage where the researcher tries to understand and define the emerging problems in detail. It involves establishing the objectives of system development and identifying potential constraints. This stage is crucial as it provides a detailed definition and identification of the actual problems. Subsequently, the researcher can proceed with the comprehensive design and framework development of the application.

The stage of information system development involves working on the previously designed development plan. During the development phase, activities such as creating databases according to the design schema and building applications based on the system design are carried out.

The application will be developed as a website using the PHP programming language, Laravel framework, and MySQL database. The website is accessed using the HTTP protocol, which connects the website server with the user. The website can be accessed using web browsers, such as Internet Explorer, Mozilla Firefox, and Google Chrome, on various devices including smartphones and computers. PHP is an accessible programming language that is freely accessible and can be integrated into HTML to develop interactive websites (Nixon, R., 2012).

MySQL is a program used for adding, deleting, modifying, and managing the structure of databases, also known as a Database Management System (DBMS). Using MySQL in PHP programming enhances the speed of data processing, allowing the created application to run quickly and efficiently (Nixon, R., 2012). Laravel is a framework used to build websites based on the PHP programming language. This framework is typically employed to create dynamic websites where the displayed data can be modified according to the data entered into the website.

The Testing Phase is the stage where the program undergoes testing to ensure that it functions according to the needs of both users and

developers. The first testing is conducted using the Black-box testing method. Black-box testing is an automated testing process that verifies if the program functions correctly without knowing the underlying code (Nidhra, S., 2012). The second testing phase involves system validation with experts to determine if the application is suitable for implementation in the learning process.

B. Learning Flow with Scrum Framework

The learning flow to be implemented in the course is divided into several stages, as follows:

1. At the beginning of the semester, students are assigned a task to create an application that will be developed in groups with a duration of 2 months.
2. The initial step is to create an application proposal within 1 week and present it to receive feedback from the instructor.
3. Creating a framework based on Scrum using Trello.
4. Creating a product backlog at the start of the project. The product backlog contains the features that will be included in the developed application.
5. In Scrum, the application development process is divided into smaller parts called sprints. Within a Scrum period, there are several stages: planning, building, testing, and reviewing, which are conducted over a period of 1 to 3 weeks.
6. In Scrum, there are three events: sprint planning, daily scrum, and sprint review.
7. At the beginning of each sprint period, each group creates a sprint planning that specifies the features to be worked on during that sprint. Feature selection is usually based on priority. The document generated for each sprint planning is called the sprint backlog, which is derived from the product backlog. The difference is that the sprint backlog further details the features to be worked on and assigns tasks to each group member.
8. During the sprint process, daily scrum meetings are held. In the course setting, daily scrums do not have to be conducted every day; they can be scheduled as needed by each group.
9. Application development is carried out by each group member in parallel, according to the assigned tasks determined during the sprint planning stage.
10. At the end of each sprint period, a sprint review is conducted to discuss the work accomplished during the sprint and identify improvements for the next sprint.
11. The sprint process is repeated until all the features have been developed.
12. At the end of the semester, the project will be presented in class.

C. System Design

Design is the planning phase regarding the architecture and flow of the application. In the planning phase, flowcharts will be used to visualize the overall flow of the application. There are two main user types who will use this application, aside from the admin who manages the application.

Basically, the application is designed to record all activities that students will undertake while working on their application development project throughout one semester of their studies. The process begins from registration and continues until assessment.

The design process is illustrated in Figure 2. The stages in the application that will be carried out by instructors and students in utilizing the application are as follows:

1. Students are required to register when accessing the application for the first time.
2. Students request to join the class they are enrolled in.
3. The instructor of the class approves the request, making the student a participant in the class.
4. The instructor creates projects and assigns groups of students to work on each project.
5. Students, who are aware of the project assignments and their group members, can initiate the project work, which will be carried out for one semester.
6. Students can start working on the project by preparing a proposal and its supporting documents.
7. During the project work, students periodically update their progress in the application,

allowing the instructor to easily monitor the project's development and the role of each student.

8. At the end of the semester, the instructor assesses the overall activities carried out by each student in completing their projects.

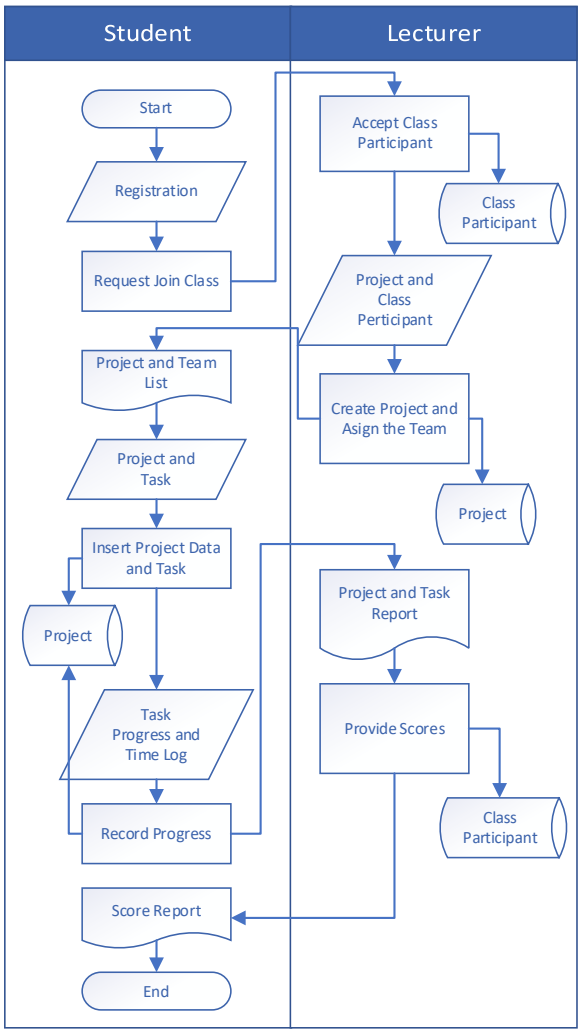

Fig. 2. System Design Process

In the application design stage, the researcher also conducts database design that will be implemented in the application. The database plays a crucial role in the application to store all the data. The detailed visualization of the database design is captured in Figure 3.

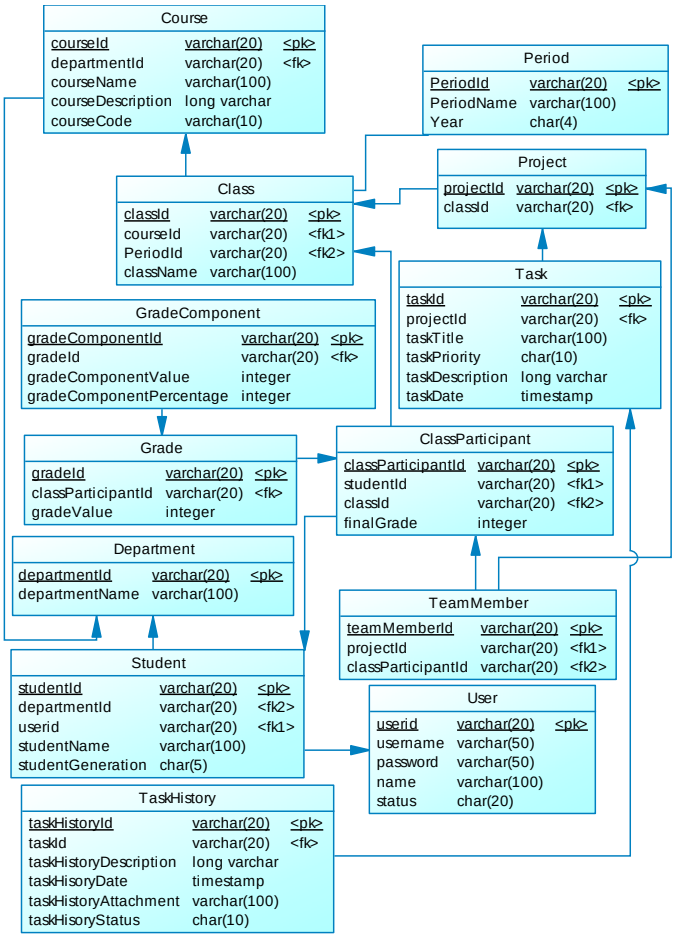

Fig. 3. Physical Data Model

RESULT AND DISCUSSION

This chapter will discuss the results of the Development of a Monitoring Application for Project-Based Learning in the Programming Course with the Scrum Framework at the Faculty of Engineering, Universitas Negeri Surabaya, based on a web-based platform.

A. System Implementation

Here are the results of the application design implementation.

1) Login Page

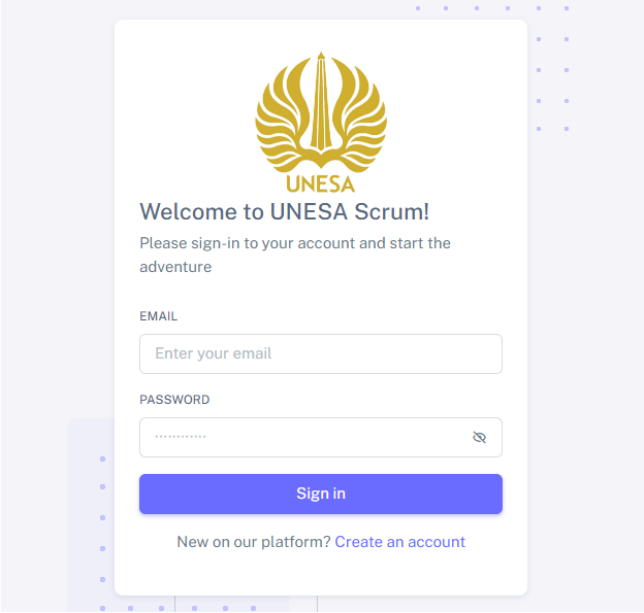

Fig. 4. Login page

The login page serves as the initial interface of the application. Users utilize this page to log into the application by entering the email and password that they have previously registered in the application.

2) Registration page

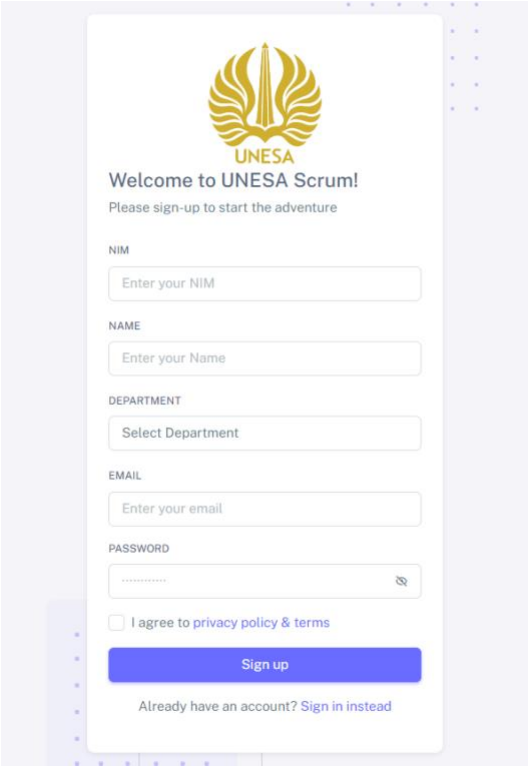

Fig. 5. Registration page

For students who do not have an account yet, they can register on the registration page. After successfully obtaining an account, students can access the application, but the class enrollment and project assignment will be done by the instructor of the class.

3) Dashboard Page

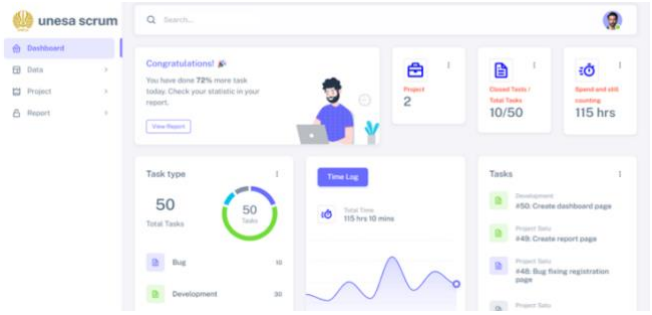

Fig. 6. Dashboard page

The first page that will appear after a successful login is the dashboard page. On the dashboard page, users can view a summary of project data, tasks, and time logs presented in graphs and lists. On this page, students can only view project data from their own group, while instructors can view data from all projects within their class.

4) Course Class Page

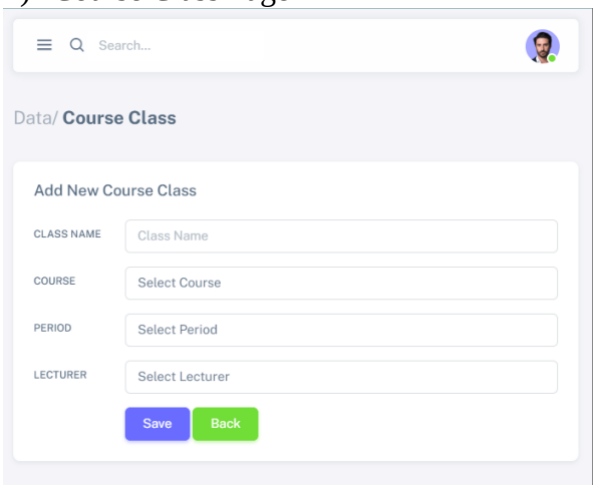

Fig. 7. Course class page

The first thing that instructors need to do at the beginning of each semester is to create classes corresponding to the courses they teach. The class creation is done independently by the instructors through accessing the "Course Class" menu. Once the class is successfully created, students who are enrolled in that class can request to join. The instructor can then approve the join request made by the students to become members of the class.

5) Project Page

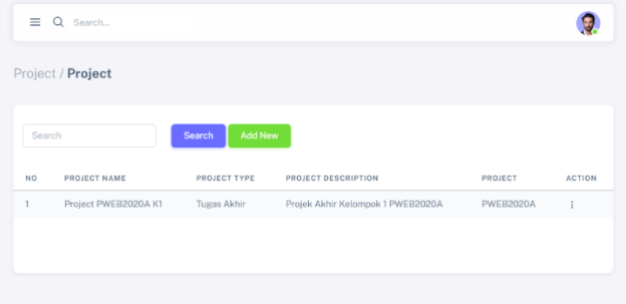

Fig. 8. Project page

Each class will consist of multiple projects. After successfully creating a class, the next step for the instructor is to create projects according to the number of groups in the class. Once the groups are created, the instructor then assigns the participating students to the available project groups.

6) Task Page

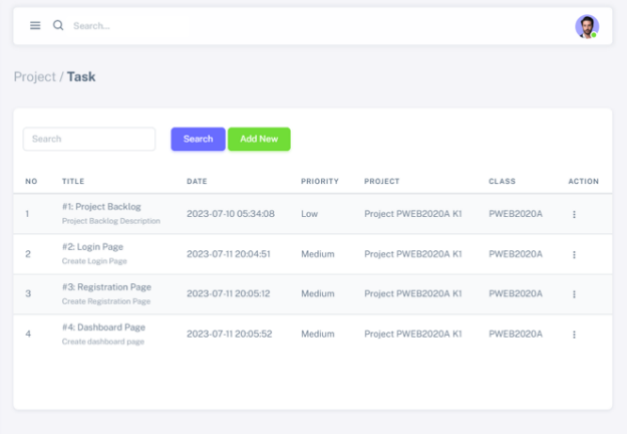

Fig. 9. Task page

After the group allocation is completed, students can start using the application to report their activities in working on the project, which is a major assignment for the class. The task page is the most frequently accessed page by students. The project will be carried out for one semester, and all activities must be reported in the application for regular monitoring by the instructor.

7) Time Log Page

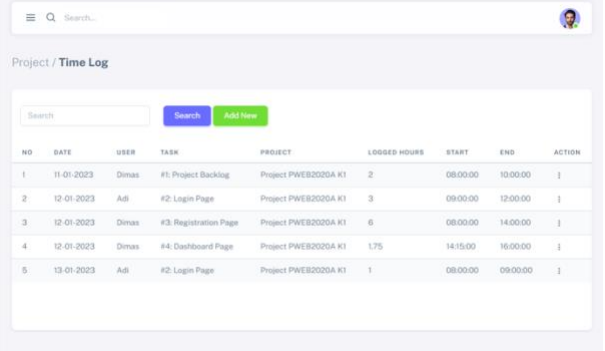

Fig. 10. Time log page

On the Time Log page, students can record the time and activities they have worked on each day. Meanwhile, for instructors, they can monitor the activity history of each student on this page.

8) Grade Page

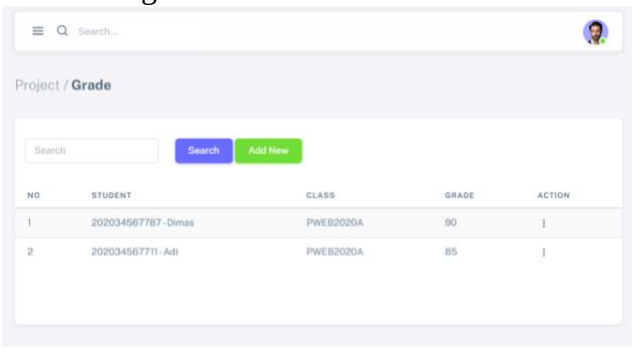

Fig. 11. Grade page

The grade page is used by instructors to input grades for each student. The grading components can be flexibly set by each instructor.

9) Report Page

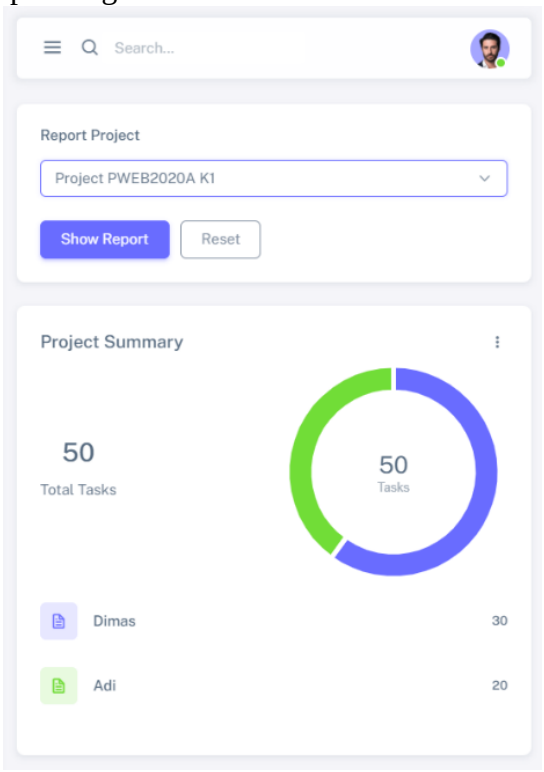

Fig. 12. Report page

On the report page, instructors can view a summary of each student's activities in working on the project throughout the semester. The report page facilitates the instructor in assessing each student's performance.

B. Testing

The results of the testing conducted on the Monitoring Application for Project-Based Learning in the Programming Course with the Scrum Framework are shown in Table 1. The testing was carried out to verify whether each feature functions correctly as intended.

Table 1. Application Testing Results

No	Objective	Input	Output	Status
1	Students can register	Student data	The system can store registration data and create new accounts.	Success
2	The instructor can create and manage class data.	Class data and class participants.	The system can store and display class and participant data.	Success
3	The instructor can create and manage project and group data.	Project and group data.	The system can store and display project and group data.	Success
4	Students can input and manage task and activity data.	Task and activity data.	The system can store and display task and activity data.	Success
5	Instructors can monitor the activity data stored in the system.	-	The system can display data and reports of student activities stored in the database.	Success
6	Instructors can enter student grades.	Student grade data.	The system can store and display grade data.	Success

CONCLUSIONS

Based on the stages carried out in the development of the Monitoring Application for Project-Based Learning in the Programming Course with the Scrum Framework, the following results were obtained:

1) Successfully developed the Monitoring Application for Project-Based Learning in the Programming Course by implementing the Scrum Project Management Framework into the application.
2) The application was built as a web-based platform using the Laravel web framework and MySQL database.
3) The testing conducted on the application was limited to functional testing.
4) This research still has great potential for further development in future studies, as follows:
5) The application still needs validation involving other instructors, so it can be further improved in terms of features and design.
6) Other frameworks or development methods can be added to the application as alternative options, making it more flexible to adapt to different conditions.
7) The application can be further enhanced by adding complementary features and improving the user-friendly interface.
8) Developing a Kanban Board can facilitate users in utilizing the application.

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