Design of Python Programming Learning Media Interaction Design Using the UCD Method

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ABSTRACT

Keywords: interaction design, learning media, python programming, user-centered design (UCD), iterative evaluation.

Programming learning media plays an important role in helping learners master programming languages such as Python. This research aims to design an effective interaction design on Python-based programming learning media using the User Centered Design (UCD) Method, which is a design approach that puts the user at the center of attention, ensuring that the resulting product is by the user's needs and preferences. User needs analysis, prototyping, and iterative evaluation are all part of UCD's research methodology. The analysis of user needs will identify user profiles, learning problems, and interface preferences. The design process will involve creating a prototype of learning media that takes into account the needs and characteristics of the user. Iterative evaluations will be used to gather user feedback and help improve the design.

Introduction

Along with the development of the times, information technology students are required to understand programming languages, because programming languages are the main thing in carrying out a software system that will be used. (Sugosha, Andreswari, & Hardiyanti, 2021). Python is one of the most widely used computer programming languages in the world. It was first released in the 1990s and is now used to build millions of apps, games, and websites. Many schools and colleges use it as one of the introductory programming languages taught to students. (Kurniawati, Dahlan, & Faisal, 2022). However, many students still have difficulty in making programs using this Python language. In the accumulated predictive time ± 32 hours/semester. For each student, this is still considered insufficient for mastery of the programming language. (Pratiwi & Iriani, 2024).

Based on a survey conducted by researchers on 43 Telkom University students through Google Forms, the results show that 58.1% of students can create programs using Python, while 41.9% of them are unable to do so (Pratiwi & Iriani, 2024). Students face several main difficulties in learning the Python programming language, including the lack of practice problems and programming examples, difficulties in handling errors, difficulties in applying syntax correctly, and difficulties in understanding basic concepts.

Of all these difficulties, the lack of practice questions and programming examples ranked highest with a percentage of 64.3% (Setyaningsih & Sutama, 2023). In addition, according to 42.5% of respondents, learning apps like Geeksforgeeks are still considered too theoretical and lack adequate practice, including incomplete video tutorials. Telkom University students expect features such as comprehensive video tutorials, practice questions to test understanding, and material on basic Python concepts to overcome these problems (Wardianti & Rini, 2024).

The solution in the form of a website was chosen because it is more accessible and flexible and developed with interactivity features to increase student engagement. (Pujianto, Setiawan, Rosyid, & Salah, 2019). This statement is strengthened by previous research that proves that there is a change in students' attitudes and learning outcomes after the implementation of learning that utilizes website-based learning media as in the thesis written entitled Development of Website-Based Integrative Learning Media Through the Moodle Portal in Class V Madrasah Ibtidaiyah Negeri 2 Malang compiled by Maulida Fikria Nasol. (Alfarizi, Al-Farish, Taufiqurrahman, Ardiansah, & Elgar, 2023). This thesis was written in 2017 to develop a product in the form of web-based learning media using the mödle portal and focusing on integrative thematic learning. The results of this development show that the development of integrative thematic learning media is proven to be effective and interesting based on the results of the pretest, post-test, and student responses. (Raharjo & Subhiyakto, 2024).

The success of learning media does not only depend on the content delivered but also on the user experience provided by interaction design. In this context, the User Centered Design (UCD) method is a strategic approach to ensure that users (students or beginners in Python programming) are actively involved in the design process to meet their needs and expectations. (Clinton & Sengkey, 2019).

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Based on these backgrounds and problems, researchers will conduct research and design web-based interaction designs with features, comprehensive tutorial videos, material on basic Python concepts, and practice comprehension test questions. It is hoped that the interaction design designed using the User Centered Design (UCD) method can help to improve students' ability to create programs using Python.

The objectives of this study are:

1. Produce an interaction design of the Python programming language learning media application that can help overcome learning difficulties for Telkom informatics students using the User Centered Design method.
2. Get the usability value of the Python programming language learning media application that has been created using SUS.

Method

This research uses a qualitative approach to gain an in-depth understanding through questionnaires and interviews with users, namely informatics students about user needs and designing learning media with a focus on interaction.

Place and Time of Research

This research was carried out at Telkom University and several others, with the author pursuing an S1 education majoring in Informatics. The research time covers a specific period, starting from the analysis stage to implementation and evaluation.

Research Stages

This research has several stages or flows that can be used in solving problems that occur and can also help provide user interface design results that are by the needs using the User-Centered Design (UCD) method.

Design Solution

1. Low Fidelity

Low Fidelity At this stage, the creation of Low Fidelity begins, which is the initial stage of designing this design. Low Fidelity has no display of fonts, colors, logos, or other design elements and consists only of a skeleton.

2. High Fidelity

After making low fidelity, then design high fidelity so that the design that has been made is easier for users to understand. In this high-fidelity design, images, icons, and colors will be given to clarify the design that has been made.

3. Prototype

After completing the creation of the low-fidelity and high-fidelity designs, the next step is to prototype the high-fidelity designs that have been created. This stage is important to ensure the connection between each design that has been made. Prototyping is carried out to test the concept or work process of the product that has been designed.

4. Evaluate Design

In the evaluation design stage, the author conducted tests with Usability Testing on users (Telkom University informatics students and several others). The test was carried out using the System Usability Scale (SUS) measurement tool to measure user satisfaction (informatics students of Telkom University and several others) with the design solutions made.

5. Drawing conclusions

At this stage, conclusions are drawn from the results of the interaction design that has been made. The results of the conclusion must be able to answer the existing problems. Furthermore, the provision of suggestions for further research.

Results and Discussion

Specify the user requirements.

At this stage, the needs of users will be explained based on the data that has been obtained from the results of the interview and also the user personas that have been

created so that the application created can help users achieve the goals they want to achieve.

Table 1
User Requirements

It	Needs	Requirements
1	Programming learning practice instructions are not only full text.	The Learning feature is in the form of video tutorials that users can follow. The video tutorial will contain complete learning instructions and simplified examples to improve memory. In addition to the tutorial video, there will be readings explaining the material.
2	Leveling Python Programming learning materials to improve understanding of Python.	Features of Python material that will be explained about the basics of programming, its benefits, as well as examples of coding examples and how to do it.
3	Practice questions to understand better after the material better.	The practice feature is in the form of a collection of questions according to the material that has been read. Questions will provide multiple choice, essay, and upload coding results.
4	Discussion to ask things that are not understood so that you can understand better.	The discussion forum feature is a forum where you can ask anything related to the material or coding questions.

Mental Model

A mental model is an explanation of how a person understands, describes, or explains how they believe something operates. In terms of user experience (UX), mental models refer to how users or designers conceptualize the operation of a system or product. (Sudirman, Lase, Syafriyandi, & Gobal, 2024). This is the mental model of the system designer of a learning application intended for Python programming:
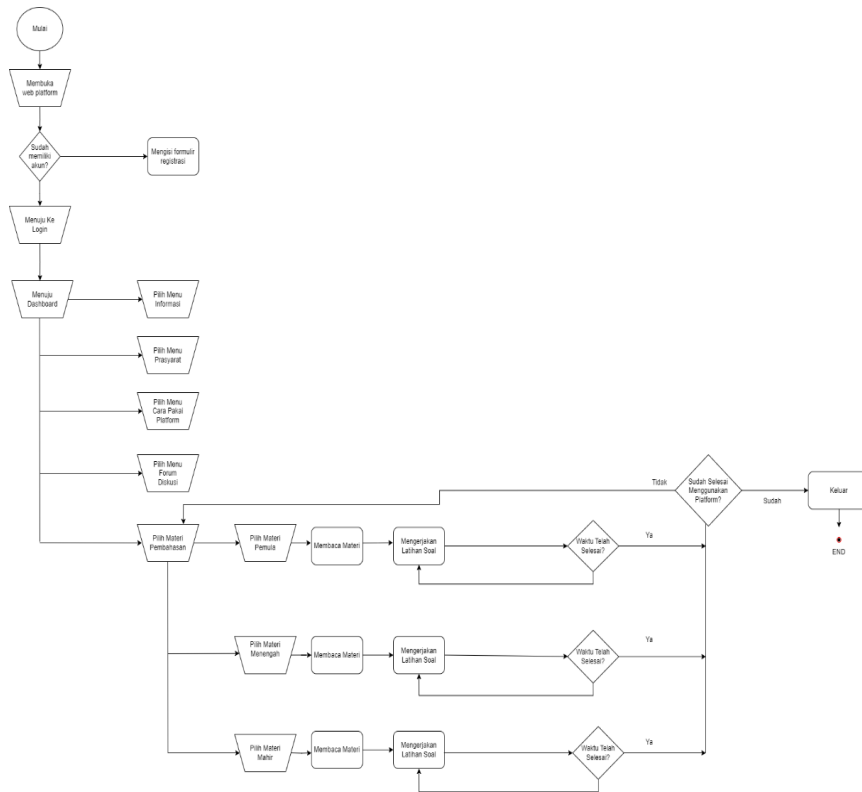
Hierarchical Task Analysis

The process of analyzing user tasks using Hierarchical Task Analysis (HTA) is carried out to describe what activities or workflows users need to do to achieve their goals. In this study, HTA users were used to describe how users access learning materials and access practice instruction videos in Python programming learning applications.

Create design solution

At this stage, the researcher designed an interface interaction design for a Python programming learning application. The design starts from a low-fidelity prototype in the form of an initial sketch in the form of a wireframe, then from the wireframe that has been made, a high-fidelity prototype modeling is carried out in the form of a prototype that contains detailed images, icons, typography, themes, interactions and has functionality that almost resembles the final product. (Azhar, Defriani, & Hermanto, 2023).

a) Low-fidelity and High-fidelity Landing Page CreationThe landing page shown in Figure 1 is the user interface of the taught coding application.
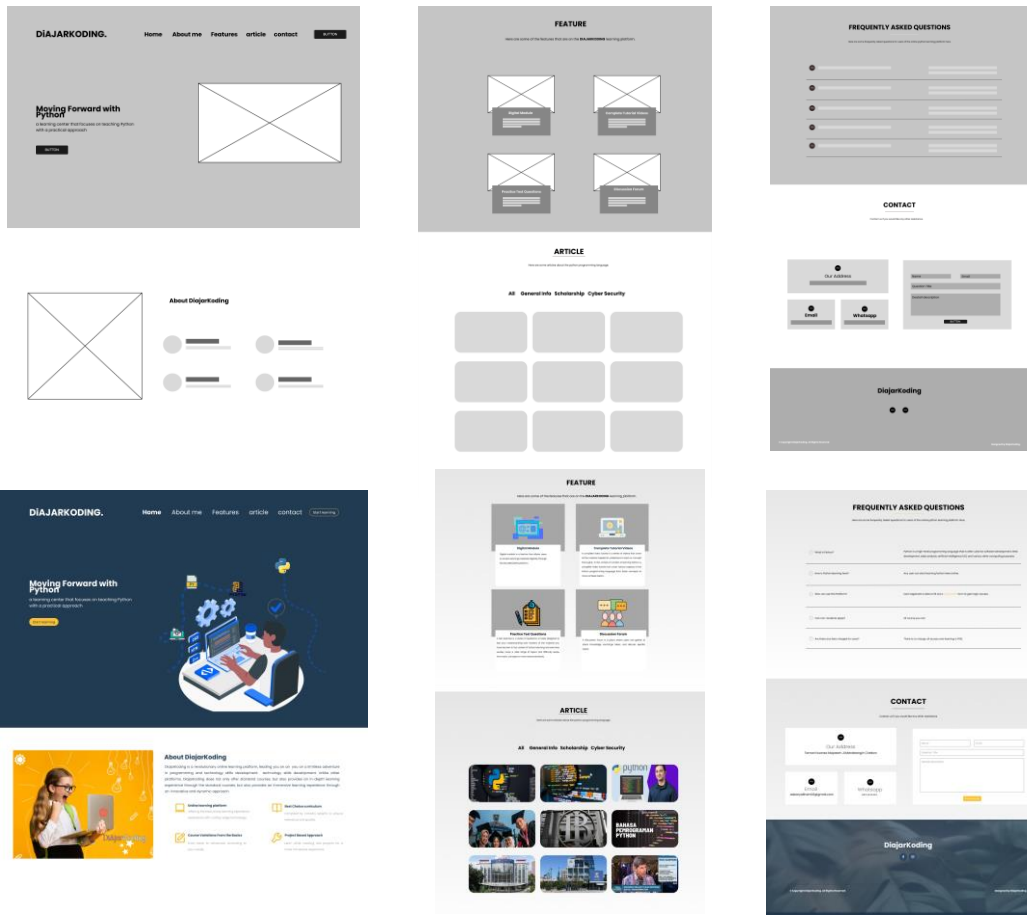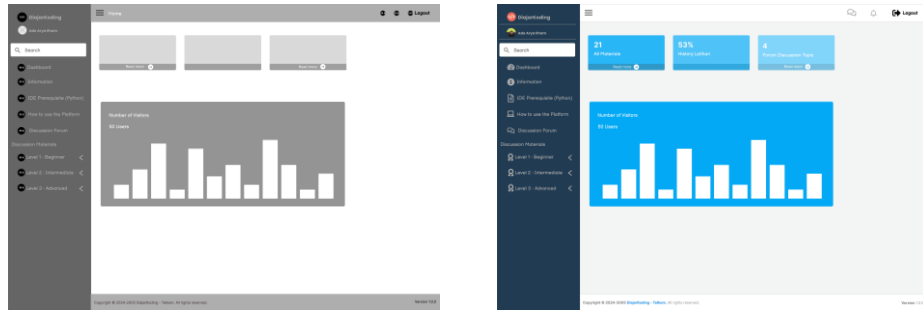
b) Low-fidelity and High-fidelity Register and Login pages are designed for Teachable Coding applications. The Login page allows users to log in with an email and password, while the Register page is used for new user registration.
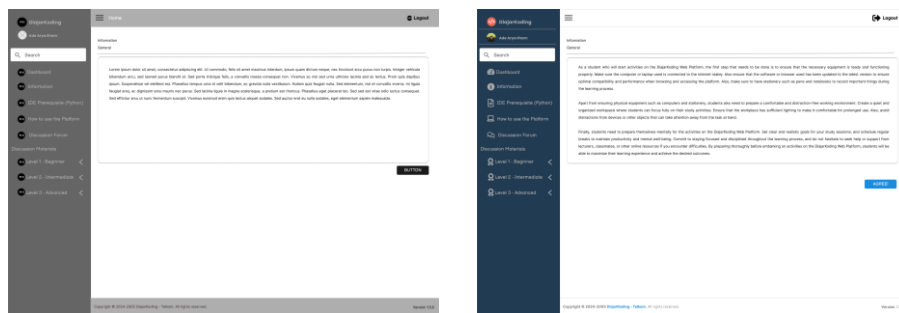
c) Creating Low-fidelity and High-fidelity Dashboard PagesThe dashboard page shown in Figure 3 is the main page visible to users after successfully logging into a taught coding application.

d) Creating
Low-fidelity and High-fidelity Information The information page shown in Figure 4 is a page that contains information about the taught coding application.

e) Creating
Low-fidelity and High-fidelity IDE Prerequisite Pages (Python)The prerequisite pages shown in Figure 5 provide information about the hardware specifications required to use the text-coded application.
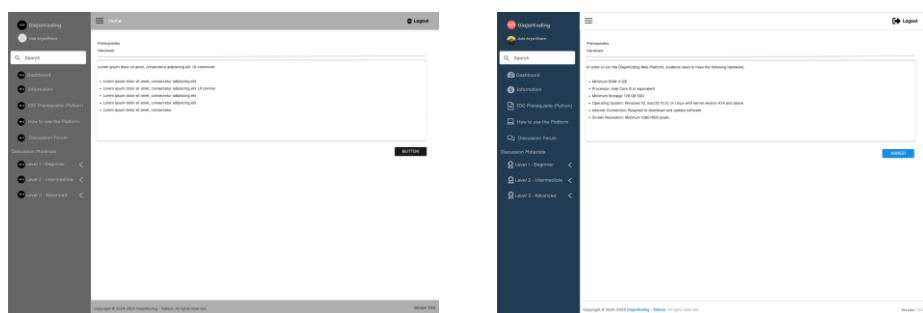
f) Pembuatan Low-fidelity dan High-fidelity
Halaman How to use the Platform

The user guide page in Figure 6 provides instructions on how to use the taught app so that users don't have any difficulties.
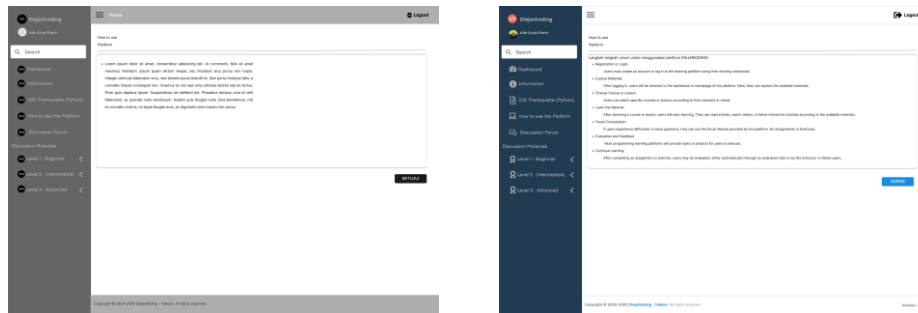
g) Creating Low-fidelity and High-fidelity Discussion Forum PagesThe discussion forum page shown in Figure 7 is a place for users and mentors to discuss and exchange information.
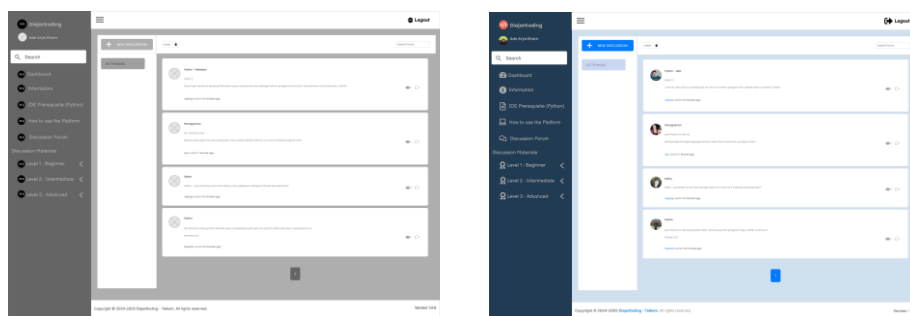
h) Low-fidelity and High-fidelity Creation Level 1 Pages - BeginnersThe entry-level pages shown in Figure 8 provide learning materials for beginner-level in taught coding applications.
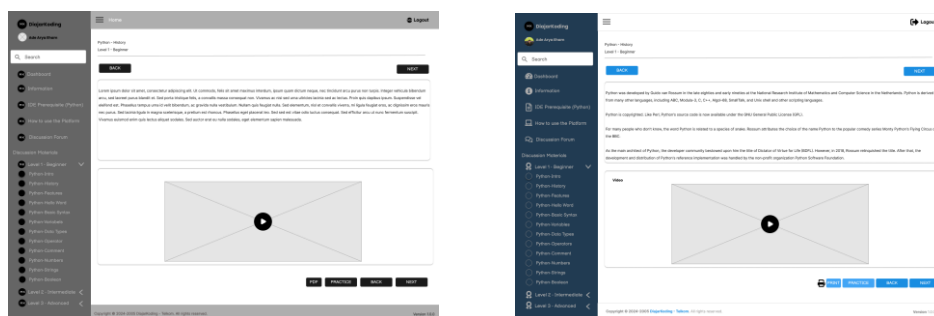
i) Low-fidelity and High-fidelity Level 2 Pages - IntermediateThe mid-level pages shown in Figure 9 provide learning materials for intermediate levels in a taught coding application.
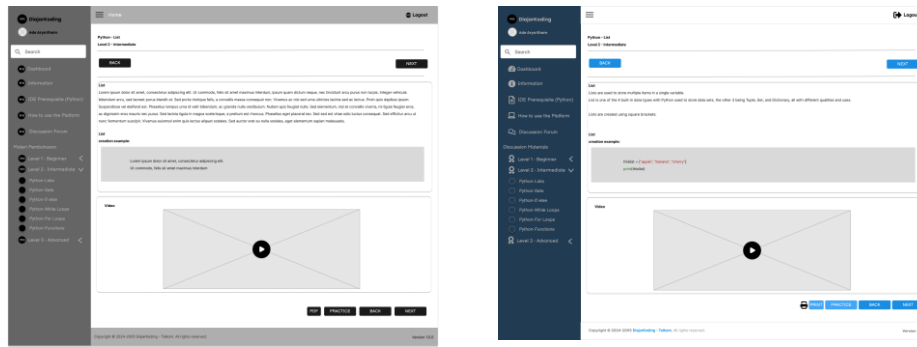
j) Low-fidelity and High-fidelity Creation Level 3 Pages - ProficientThe advanced level pages shown in Figure 10 provide learning materials for the proficient level in the taught coding application.
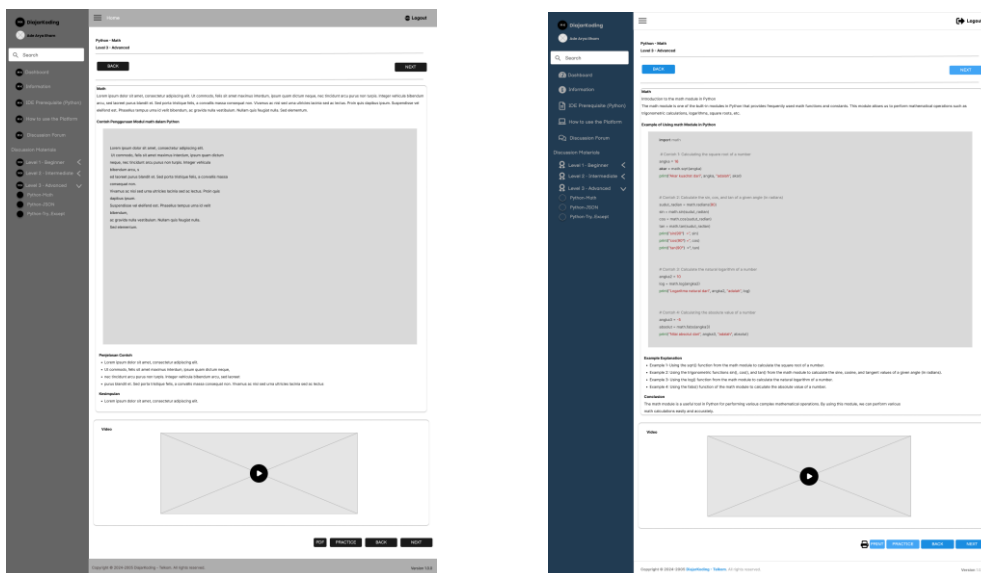
k) Creating Low-fidelity and High-fidelity Practice Questions PageThe practice page shown in Figure 11 is a page for working on practice questions after studying the material on the taught coding application.
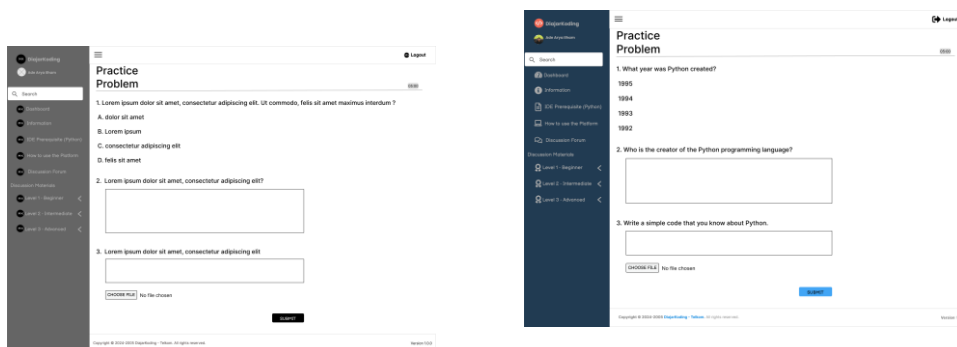
l) Low-fidelity and High-fidelity User Settings Page The user settings page shown in Figure 12 allows users to set profiles, such as name, email, password, address, and contacts within the coded app.
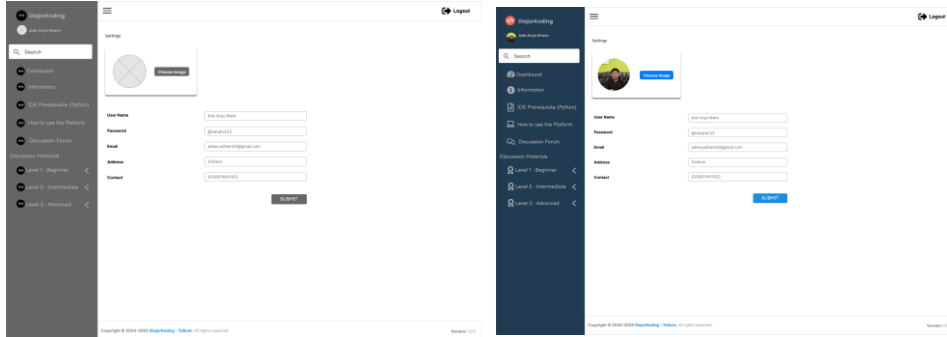
Test participants will be given several questions that need to be answered, the questions are as follows:

Table 2
SUS Question

Scenario	Description
1	Accessing the landing page of DiajarKoding
2	Registration
3	Accessing Login /onboarding
4	Accessing the dashboard
5	Accessing information
6	Accessing IDE Prerequisites
7	Accessing How to Use the Platform
8	Accessing Discussion Forums
9	Accessing Level 1 - 3 Materials
10	Accessing Practice Questions
11	Accessing User Settings

Analysis of Test Results

After the testing and filling out the questionnaire was completed, the following results were obtained:

Table 3
Original score of SUS Questionnaire

No	Respond	Original Score									
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
1	R1	5	1	5	2	5	1	5	1	5	2
2	R2	4	2	4	3	4	2	4	2	4	2
3	R3	4	2	4	2	4	2	4	2	4	3
4	R4	5	2	5	2	5	1	5	1	4	2
5	R5	5	2	4	2	4	2	4	2	4	2
6	R6	4	2	4	2	5	2	4	2	4	3
7	R7	4	1	5	1	5	2	5	1	5	1
8	R8	5	2	5	2	4	1	5	1	5	2
9	R9	5	4	5	4	5	3	5	3	5	5
10	R10	4	2	4	4	4	3	4	2	4	4
11	R11	5	1	5	2	4	2	4	1	4	2
12	R12	4	2	5	2	4	2	5	1	4	4
13	R13	4	2	4	3	5	2	4	2	4	2
14	R14	4	2	4	2	4	2	4	1	4	2
15	R15	5	1	4	2	4	1	4	1	5	2
16	R16	5	1	5	2	4	2	5	1	4	2
17	R17	5	2	4	2	4	1	4	2	4	2
18	R18	4	2	4	2	4	2	3	2	4	1
19	R19	4	2	4	2	4	2	4	2	4	2
20	R20	4	5	4	3	4	3	5	2	4	3
21	R21	4	2	5	2	4	2	4	2	5	4
22	R22	4	2	5	4	4	2	5	2	4	3
23	R23	4	2	4	4	4	2	4	2	4	4
24	R24	5	2	5	2	5	2	4	1	4	2
25	R25	4	1	5	1	4	2	5	1	4	3

26	R26	5	2	4	4	4	2	5	1	4	2
27	R27	5	5	5	5	5	3	3	2	4	3
28	R28	4	2	4	3	4	3	3	3	3	3
29	R29	5	2	4	1	4	2	4	1	4	4
30	R30	4	2	4	2	5	2	4	2	3	2
31	R31	4	1	5	1	4	2	4	1	4	1
32	R32	4	2	4	4	4	1	4	1	2	2
33	R33	5	2	4	2	4	2	4	2	4	2
34	R34	5	2	4	2	5	2	5	2	5	4
35	R35	5	2	4	3	5	2	5	1	1	5
36	R36	4	2	2	2	4	2	4	2	4	5
37	R37	4	1	5	2	4	2	5	2	4	3
38	R38	4	2	4	2	4	3	4	2	3	4
39	R39	4	2	4	2	4	2	5	2	5	2
40	R40	5	2	4	2	5	2	4	2	4	2

The results obtained still do not represent the true usability value. However, the results obtained do not accurately reflect the actual usability value. (Wijaya, Arif, Aini, & Putri, 2024). To determine the true score, the original score for odd-numbered questions must be subtracted by one point, and for even-numbered questions, the original score must be subtracted by five points. The number must then be multiplied by 2.5. The following formula can be used to determine the actual value of the average calculation.

$$\underline{X}\,SUS = \frac{SUM(2{,}5 \times (SUM((Qganjil - 1) + (5 - Qgenap))))}{Jumlah\ Peserta}$$

From the formula above, the average score for usability testing in the interaction design of Python programming learning applications shows a value of 77 with a grade of C which has Adjective Ratings as GOOD and ACCEPTABLE.

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Table 4
Usability Final Score

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Sum	Value (Qty x 2.5)
4	4	4	3	4	4	4	4	4	3	38	95
3	3	3	2	3	3	3	3	3	3	29	73
3	3	3	3	3	3	3	3	3	2	29	73
4	3	4	3	4	4	4	4	3	3	36	90
4	3	3	3	3	3	3	3	3	3	31	78
3	3	3	3	4	3	3	3	3	2	30	75
3	4	4	4	4	3	4	4	4	4	38	95
4	3	4	3	3	4	4	4	4	3	36	90
4	1	4	1	4	2	4	2	4	0	26	65
3	3	3	1	3	2	3	3	3	1	25	63
4	4	4	3	3	3	3	4	3	3	34	85
3	3	4	3	3	3	4	4	3	1	31	78
3	3	3	2	4	3	3	3	3	3	30	75
3	3	3	3	3	3	3	4	3	3	31	78
4	4	3	3	3	4	3	4	4	3	35	88
4	4	4	3	3	3	4	4	3	3	35	88
4	3	3	3	3	4	3	3	3	3	32	80
3	3	3	3	3	3	2	3	3	4	30	75
3	3	3	3	3	3	3	3	3	3	30	75
3	0	3	2	3	2	4	3	3	2	25	63
3	3	4	3	3	3	3	3	4	1	30	75
3	3	4	1	3	3	4	3	3	2	29	73
3	3	3	1	3	3	3	3	3	1	26	65
4	3	4	3	4	3	3	4	3	3	34	85
3	4	4	4	3	3	4	4	3	2	34	85
4	3	3	1	3	3	4	4	3	3	31	78
4	0	4	0	4	2	2	3	3	2	24	60
3	3	3	2	3	2	2	2	2	2	24	60
4	3	3	4	3	3	3	4	3	1	31	78
3	3	3	3	4	3	3	3	2	3	30	75
3	4	4	4	3	3	3	4	3	4	35	88
3	3	3	1	3	4	3	4	1	3	28	70
4	3	3	3	3	3	3	3	3	3	31	78
4	3	3	3	4	3	4	3	4	1	32	80
4	3	3	2	4	3	4	4	0	0	27	68
3	3	1	3	3	3	3	3	3	0	25	63
3	4	4	3	3	3	4	3	3	2	32	80
3	3	3	3	3	2	3	3	2	1	26	65
3	3	3	3	3	3	4	3	4	3	32	80
4	3	3	3	4	3	3	3	3	3	32	80
Average Score (Final Result)											77

User Requirements Fulfillment

After going through a series of design and development processes, all user needs that had been identified in the early stages of this project have been successfully met. Among them:

1. Program Code Exercises: Users are allowed to practice live through available videos and program code exercises. This allows users to implement their knowledge practically and get immediate feedback on the results

2. Concept Visualization: To make it easier to understand, the key concepts have been visualized so that users with different backgrounds can understand the material more easily.

3. Gradual Learning Process: The material has been arranged in systematic stages from basic to advanced, which helps users follow the learning flow according to their ability level.

Conclusion

Based on the results of analysis and testing, the design of Python learning application interaction design with the User Centered Design (UCD) method has successfully achieved its goal. The app is capable of providing an intuitive and effective learning experience, according to the needs and characteristics of the user.

Usability testing showed a SUS score of 77, which is included in the GOOD category with a grade of C and ACCEPTABLE in the Adjective Ratings. This indicates that the app meets the recommended usability standards and provides convenience in its use. For further development, it is recommended to conduct a more in-depth analysis of each SUS question to identify aspects of usability that can be improved, in order to meet user expectations more specifically.

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