

A. System Usability Scale (SUS)

The System Usability Scale (SUS) is a widely used method for evaluating the usability of a system. It was introduced by John Brooke in 1986. Table I, which is composed of 10 questions, delineates each question from the questionnaire. The questionnaire contains 5 positive questions and 5 negative questions, which encompass various aspects of user experience and ease of use.

TABLE I. QUESTIONNAIRE OF SYSTEM USABILITY SCALE

No	System Usability Scale Questions
1	"Saya merasa mudah belajar pemrograman Python menggunakan aplikasi ARPY." I find it easy to learn Python programming using the ARPY app.
2	"Saya merasa aplikasi ARPY sulit untuk digunakan" I find the ARPY application difficult to use.
3	"Saya tertarik belajar pemrograman dengan metode visual/interaktif yang disediakan oleh ARPY." I am interested in learning programming using the visual/interactive method provided by ARPY.
4	"Saya merasa fitur yang disediakan oleh aplikasi ARPY tidak cukup membantu dalam belajar pemrograman." I feel that the features provided by the ARPY app are not helpful enough for learning programming.
5	"Fitur interaktif dalam aplikasi ini sangat membantu saya dalam memahami materi." The interactive features in this app are very helpful in understanding the material.
6	"Pembelajaran dengan menggunakan ARPY lebih membingungkan dibandingkan dengan metode tradisional seperti buku atau video." Learning with ARPY is more confusing than traditional methods such as books or videos.
7	"Saya merasa lebih mudah memahami konsep abstrak Python ketika menggunakan tampilan visual 3D dalam ARPY." I find it easier to understand abstract Python concepts when using the 3D visual display in ARPY.
8	"Saya merasa aplikasi ARPY tidak cukup menarik untuk terus digunakan dalam jangka panjang." I feel that the ARPY application is not interesting enough to continue using in the long term.
9	"Saya akan merekomendasikan aplikasi ARPY kepada teman jika aplikasi ini membantu dalam memahami Python." I would recommend the ARPY app to my friends if it helps them understand Python.
10	"Saya merasa aplikasi ARPY membutuhkan bantuan teknis yang sering untuk digunakan dengan efektif." I feel that the ARPY application requires frequent technical assistance to be used effectively.

The respondents are asked to rate the system using a Likert scale, with Table II detailing the ratings for each question on a scale of 1 to 5. The resulting scores are then calculated to provide a final usability score.

TABLE II. QUESTIONNAIRE SCORE RANGE

Answer	Score
Sangat Setuju (SS)	5
Setuju (S)	4
Netral (N)	3
Tidak Setuju (TS)	2
Sangat Tidak Setuju (STS)	1

The System Usability Scale formula is as follows:

$$\text{Score R} = ((Q1-1)+(5-Q2)+(Q3-1)+(5-Q4)+(Q5-1)+(5-Q6)+(Q7-1)+(5-Q8)+(Q9-1)+(5-Q10)) \times 2,5$$

Where Q1...Q10 represent the scores obtained for each question from the respondents. The SUS score, when converted using the provided formula, is ranged from 0 to 100. The resulting value indicates the extent to which the system is accepted and used efficiently by its users.

B. Evaluate Against Requirements

The data for evaluating the System Usability Scale (SUS) were obtained from questionnaires completed by 30 participants. Table III contains information about the participants who were assigned to evaluate the application using a 10-item scale, ranging from 1 (strongly disagree) to 5 (strongly agree). These scores were then used to calculate the total SUS score, which assesses the ease of use of the ARPY (Augmented Reality Python) application. The collective responses of the participants were used to comprehensively evaluate the system, providing a comprehensive overview of user interaction with the application and their perceptions of its usefulness.

TABLE III. SCORE OF SYSTEM USABILITY SCALE ARPY

No	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6	Q 7	Q 8	Q 9	Q10	Score R
1	5	2	5	2	5	2	5	2	5	2	87,5
2	5	1	5	5	5	5	5	5	5	5	60
3	4	3	4	2	5	1	5	3	4	3	75
4	5	2	4	1	5	1	5	1	4	1	92,5
5	4	3	4	2	3	2	3	3	4	3	62,5
6	4	4	5	3	4	3	4	4	5	4	60
7	5	5	4	2	4	2	4	4	5	5	60
8	5	5	5	2	4	2	4	2	4	4	67,5
9	5	4	5	3	4	3	4	4	5	4	62,5
10	3	3	3	3	3	3	4	2	5	3	60
11	3	2	5	3	4	2	5	3	4	4	67,5
12	5	2	5	1	5	3	5	2	5	5	80
13	3	4	5	5	5	4	4	2	5	5	55
14	5	5	5	4	5	5	5	3	4	2	62,5
15	5	3	5	3	5	3	5	3	5	3	75
16	5	1	5	5	5	1	5	1	5	1	90
17	4	2	5	2	4	2	4	2	5	4	75
18	5	2	5	2	4	2	4	2	4	3	77,5
19	4	3	4	2	4	2	4	2	4	4	67,5
20	5	3	4	3	5	3	5	3	5	3	72,5
21	3	2	5	2	4	3	4	2	4	3	70
22	3	2	3	2	3	3	3	2	5	3	62,5
23	4	2	4	2	4	2	4	2	4	4	70
24	3	3	3	2	3	2	4	3	4	4	57,5
25	4	2	4	2	4	2	4	2	5	3	75
26	4	3	4	2	4	2	4	2	4	4	67,5
27	5	1	5	1	5	2	5	1	5	2	95
28	3	3	4	3	4	2	3	3	4	3	60

29	3	3	4	2	4	3	3	2	5	5	60
30	4	2	4	2	4	2	5	2	5	2	80
Score Of System Usability Scale ARPY											70,25

The System Usability Scale (SUS) for ARPY was calculated based on the responses to the questionnaire, yielding a score of 70.25. The individual scores for each of the 30 participants were aggregated, and the weighted average of these scores was subsequently computed. The total score is indicative of the overall usability rating of the ARPY application. It provides insights into the extent to which the application meets the needs of its users with regard to ease of use, functionality, and user satisfaction.

System Usability Scale score threshold is generally regarded as 68, with scores above 68 indicating acceptable usability and those below 68 suggesting potential usability issues as shown in Figure 8. Given that the SUS score for ARPY is 70.25, it surpasses the established threshold, thereby signifying that the application demonstrates commendable user-friendliness and aligns with prevailing usability expectations.

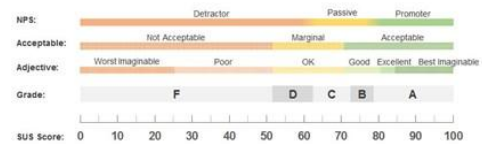


Fig. 8 System Usability Scale Scoring

CONCLUSION

In conclusion, the research successfully demonstrated that the integration of Augmented Reality (AR) with the User-Centered Design (UCD) approach significantly enhances the learning experience of Python programming. By incorporating AR technology, abstract programming concepts like data structures and branching logic were presented in a more interactive and visually engaging manner, making them easier for students to understand. The application, ARPY, developed through this study, meets the identified user requirements and achieves a satisfactory usability score of 70.25, indicating its effectiveness in terms of user-friendliness and engagement. Future work should focus on expanding the complexity of the learning content in ARPY and testing its application in diverse educational settings. Additionally, further research could explore the long-term impact of AR-based learning on programming skills and student retention rates.