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PLIDe: Implementation of VARK Theory and HCI Design Laws in Python Programming Language Instructional Design Application

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Abstract

Existing mobile applications are interactive, comprehensive yet lack of personalised learning content to cater different style of learners. PLIDe was developed for personalised learning styles and designed based on VARK theory of learning styles and Human Computer Interaction (HCI) design laws. The application was assessed before and after development for its feasibility, usability and content suitability through three online surveys with final-year Diploma of Information Technology students and one user testing with lecturers under the Department of Information Technology at Universiti Tun Hussein Onn Malaysia (UTHM) Pagoh Campus. The feasibility survey response from 144 final-year Diploma of Information Technology students indicated students favoured visual and kinesthetic learning style for programming education. The usability survey amongst 108 students from the same sample indicates high level of satisfaction of PLIDe among the respondents. Testing the quality of PLIDe with eight Information Technology lecturers under the Department of Information Technology from UTHM Pagoh Campus revealed that PLIDe contain good quality of learning material yet requires improvement on the user interface design.

1. Introduction

The conventional methods of instruction in the 'learning skills' course were observed, in which the content is presented to all students in one style that is dependent on understanding the content regardless of the diversity of their learning styles [1]. Within this context, there's a noticeable gap in offering a cohesive platform integrating different learning materials within a mobile app structure. This absence leads to considerable difficulties for users in accessing interactive exercises, tutorial videos, and comprehensive notes conveniently, thereby impeding their effective understanding of Python's complexities. Python, being one of the most popular programming languages, demands a multifaceted approach to learning due to its broad application in web development, data science, artificial intelligence, and more. Unfortunately, many existing resources are fragmented and fail to provide a seamless learning experience that accommodates the fast-paced, mobile-centric lifestyles of today's learners and individual learning preferences. Despite the lack of evidence, adherence to learning styles hypotheses is globally pervasive [2]. Visual, auditory, and read-write learners often find themselves underserved by existing platforms, which fail to adapt to their unique needs and preferences. Consequently, there's a significant market gap for a

programming education solution that not only provides a diverse range of learning materials but also incorporates a flexible instructional design framework accommodating various learning styles.

1.1 Learning Style

In the realm of modern education, the diversity of learning styles necessitates the development of instructional tools that cater to varied learner preferences. With the growing reliance on digital platforms for educational content, understanding and integrating these diverse learning styles into the design of educational applications is crucial. Python, as a programming language, has seen a surge in popularity due to its simplicity and wide range of applications. Consequently, the availability of user-friendly and effective Python learning apps on mobile platforms has become increasingly important.

Additionally, Python's increasing popularity underscores the importance of assessing the user-friendliness of Python learning apps available on the marketplace. This study aims to evaluate these apps using tools such as the Learning Object Review Instrument (LORI), with the goal of enhancing user experience and learning outcomes [3]. Furthermore, rigorous evaluation of the application's functionality and learnability is essential to ensuring that it meets the needs of its target audience effectively. Emphasising simplicity and intuitive design will allow users to navigate the app effortlessly, reducing the learning curve and maximising usability [4].

This paper aims to address this gap by providing various learning materials for Python programming language mobile applications. Furthermore, the authors seek to develop an instructional design for programming education that accommodates flexible learning styles. Lastly, this paper will evaluate the functionality and learnability of the mobile application for the Python programming language.

Ultimately, the development of such a Python programming language mobile application represents an opportunity to bridge the gap in programming education, providing users with a flexible, comprehensive, and user-friendly platform to master the intricacies of Python programming.

The following section of the literature review discusses the evaluation of mobile apps designed, followed by material and methods discussing the learning development model and the specific activities performed at each phase. Section 4 presents the results from a survey conducted during the analysis phase, including a CSUQ survey of final-year IT students and a LORI survey of lecturers in the Diploma in IT program. The results are further discussed in section 5. Finally, the concluding remark is summarised in the last section.

1.2 Related Works

Various mobile applications are available on the marketplace for learning programming topics. Table 1 shows a comparison of application features, quality, design concent, content delivery approach and scope of programming language between PLIDe with three other similar existing applications, which are Programming Hub, SoloLearn, and Programming Hero.

Table 1 *Comparison between Applications' Content*

Criteria	Programming Hub	SoloLearn	Programming Hero	PLIDe
Features	Lessons, exercise, community support	Lessons, community support, exercise	Lessons, community support, Code Samples, exercise	Lessons, quizzes, exercises
Quality	Easy to use	User-friendly	Interactive	Simplicity
Design Concept	Progress achievement	Goal based	Gamification	Personalised Learning Style
Content delivery	Text based	Text based	Text based	Personalised learning content
Programming language	Varied	Varied	Varied	Python

Engaging content and interactive lessons play a crucial role in enhancing user engagement and knowledge retention within mobile apps designed for online learning ([5], [6], and [7]). Coding challenges provide hands-on practice, while progress tracking motivates learners to achieve goals. Community support encourages collaboration and peer learning. Table 2 compare the features of Programing hub, SoloLearn, Programming Hero and PLIDe.

Table 2 *Comparison between Applications Functionalities*

Criteria	Programming Hub	SoloLearn	Programming Hero	PLIDe
Learning Style Options	✗	✗	✗	✓
Quizzes	✓	✓	✓	✓
Progress Tracking	✓	✓	✓	✗
Exercises	✓	✓	✓	✓
Video Tutorials	✓	✓	✗	✓

Although lack of progress tracking features, PLIDe exhibits combination of functionalities presented in the compared applications as a whole.

2. Material and method

This section discusses the specific activities and techniques performed at each phase in developing Python Programming Language Instructional Design (PLIDe) application as well as the materials used for data collection stage.

2.1 Methodology

PLIDe was developed using the ADDIE methodology. Specifically, the model's name is an acronym for the five phases: analysis, design, development, implementation, and evaluation [8].

2.1.1 Analysis phase

An online feasibility survey was conducted among final-year students of the Diploma in Information Technology (IT) course at the Universiti Tun Hussein Onn Malaysia (UTHM) Pagoh Campus. The survey contains demographic and two additional sections to identify IT students' learning style preferences and functionalities expected in a programming educational mobile application. The survey is accessible at https://forms.gle/tZSKTbXUJChhsrbi9.

2.1.2 Design Phase

The application was developed using Flutter and Dart programming language. Figma was used to create a mock-up to understand the application's functionality. Additionally, Miller's law was applied in designing the application by breaking down educational materials and user interfaces into smaller, and understandable modules. Fitt's law was also applied in designing and positioning the menu buttons for ease of use. This approach helps make information more focused and valuable for learners [9].

2.1.3 Development Phase

PLIDe was coded using Flutter software based on mock up designed in the previous phase. All related content and multimedia elements were integrated using Firebase for data storage. Fig. 1 shows the interface of the PLIDe application. Fig. 1(a) displays the learning style option page, where use can custom learning content such as notes and exercise according to their leaning preference; visual, auditory, read-and-write, and kinaesthetic. Fig. 1(b) shows the menu options available for auditory leaner. Fig. 1(c) shows the exercise where user can check their answer on a given question. Kinaesthetic learner can practice hands on coding on code playground as in Fig.1 (d). On the other hand, auditory learner can watch and listen to video lectures as in Fig.1 (e). Visual learners are provided infographic notes as in Fig. 1 (f).

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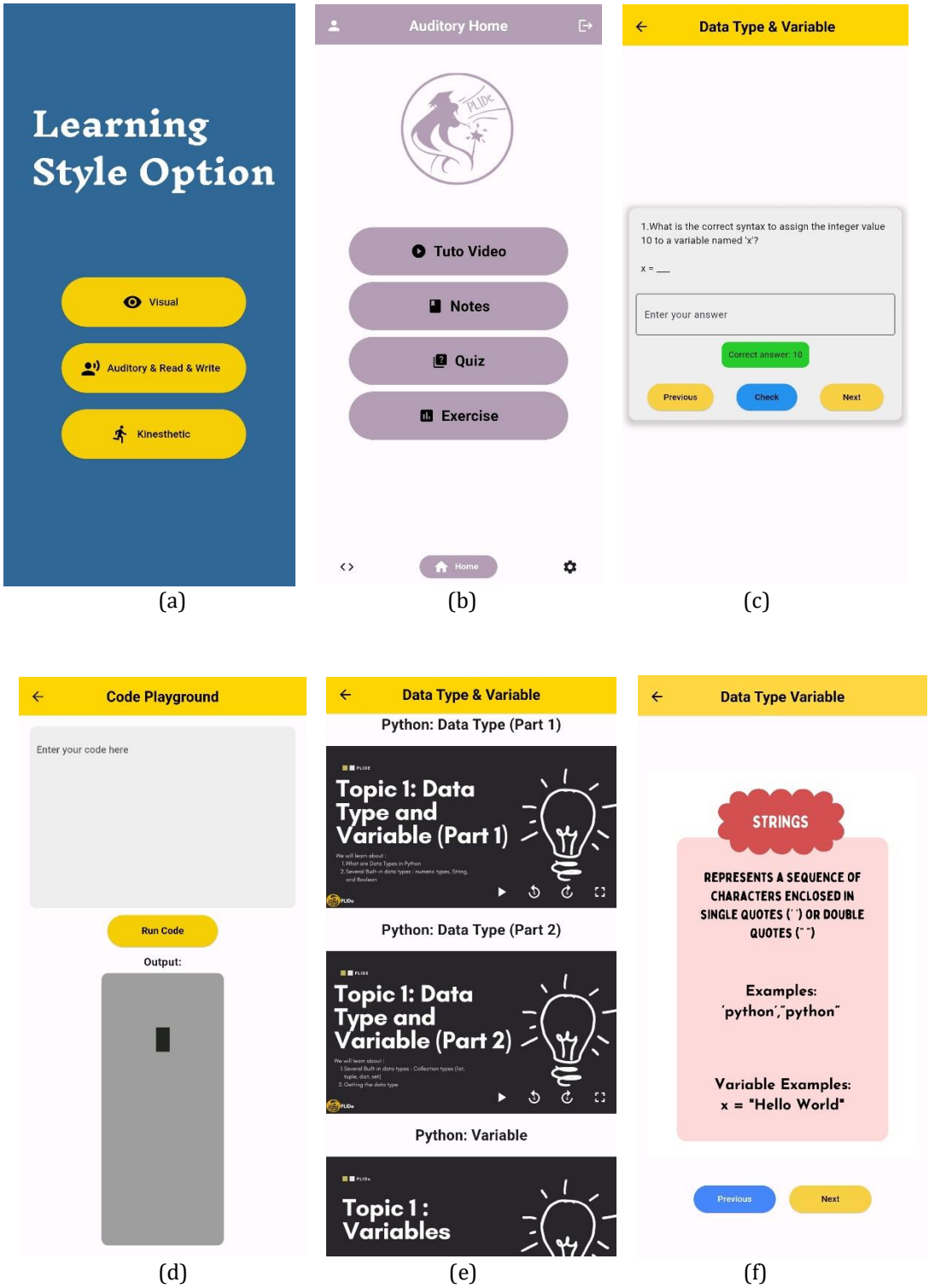

Fig. 1 *Interface of the PLIDe Application (a)Learning style option; (b)Auditory Leaner Menu Options; (c) Exercise; (d) Code Playground for Kinesthetics Learner; (e) Video notes for auditory learner; (f) Infographic notes for visual learner*

2.1.4 Implementation Phase

The application was launched and distributed to end-users through a WhatsApp group consisting of final-year students in Diploma IT. Additionally, it was published on Google Play using a platform provided by UTHM, under CEDS, UTHM user account.

2.1.5 Evaluation Phase

The usability, pedagogy and technical quality of PLIDe was evaluated through two online surveys using the Computer System Usability Questionnaire (CSUQ) survey and a Learning Object Review Instrument (LORI) questionnaire to gather feedback from UTHM final-year students and lecturers of the Diploma in Information Technology. The CSUQ google form link was disseminated to the students, while the LORI questionnaire google form link was distributed to the lecturers. Students were required to download and explode PLIDe from Google Play prior to the survey.

The usability survey consists of demographics, a PLIDe usability review using the CSUQ questionnaire items, and suggestion and recommendation sections. The suvey were provided to the student to evaluate whether the objectives of the application had been achieved and to identify any shortcomings in its functionality and usability. The questions are categorised into four areas, which are usefulness, information quality, interface quality and overall usability.

Additionally, the LORI questionnaire aimed to ensure that PLIDe is of high quality, effective and led to better learning experiences and outcomes. The evaluation involved face-to-face testing with the lecturers. The testing began by briefly explaining the PLIDe application to the lecturers, followed by gathering feedback about the application from the lecturers. After the feedback session was complete, the lecturers are required to fill out the LORI questionnaire. The LORI questionnaire survey on nine areas which are: content quality, learning goal alignment, feedback and adaptation, motivation, presentation design, interaction usability, accessibility, reusability, and standard compliance.

3. Result and Discussion

The following sections present and discuss the results of the feasibility survey and CSUQ survey for final-year IT students, and a LORI survey for lecturers in the Diploma in IT.

3.1 Result

A total of 144 students completed the feasibility survey with mostly male respondents. Fig. 2 illustrates the resulted learning styles preferences for studying programming subjects among the respondents categorised by their programming expertise. Half of the respondents considered themselves as an intermediate and 40% of the respondents considered themselves as beginner who can write working code with correcting few errors without complete understanding on how the code work. Only one respondent selected novice, while 10 respondents chose advanced, and only three selected experts.

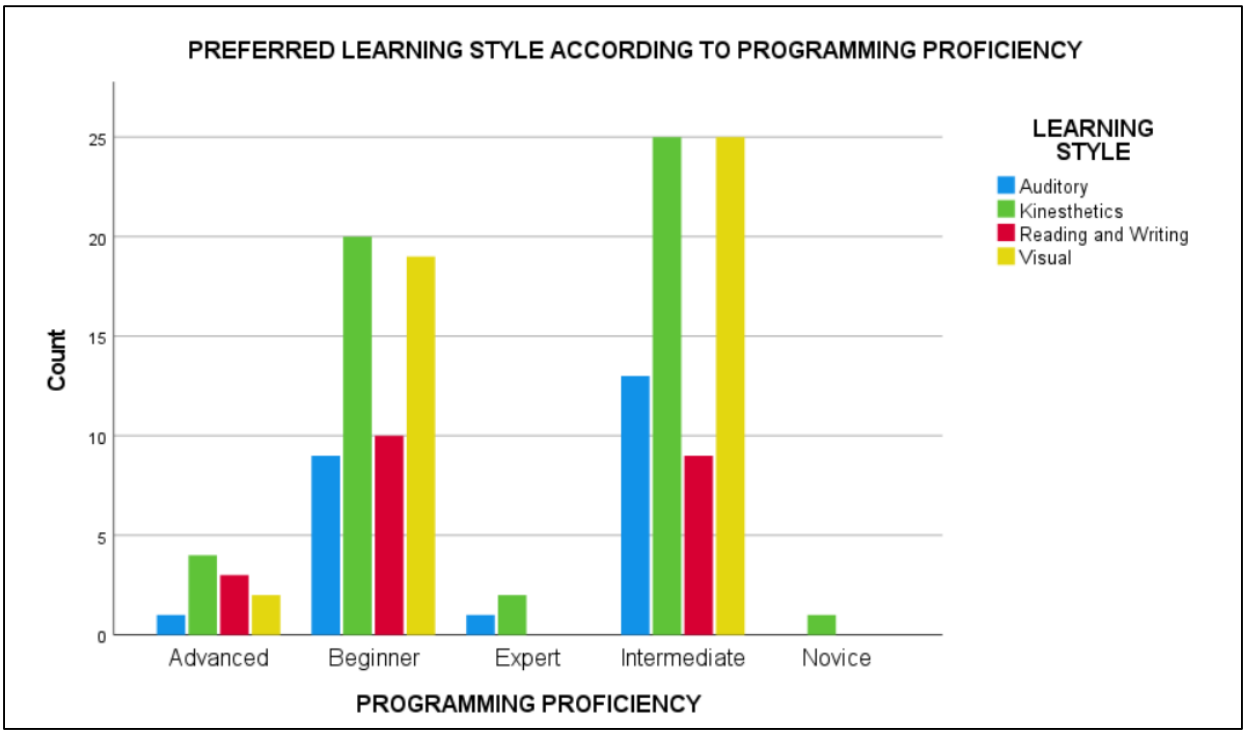

Fig. 2 *Results of the Analysis Phase Survey on Learning Styles*

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Eight lecturers from the Department of Information Technology (JTM) responded to the LORI Questionnaire. Fig. 3 shows a snapshot of the testing session.

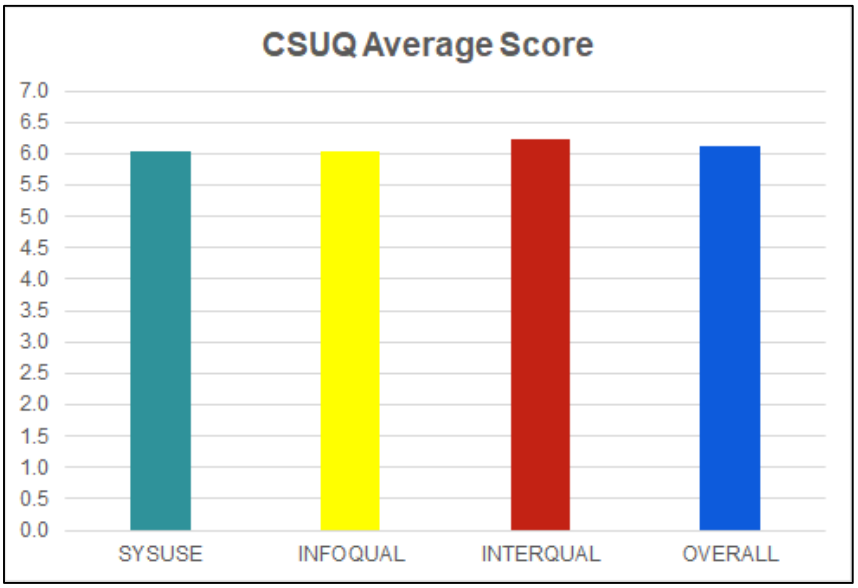
(a) (b)

(c) (d)

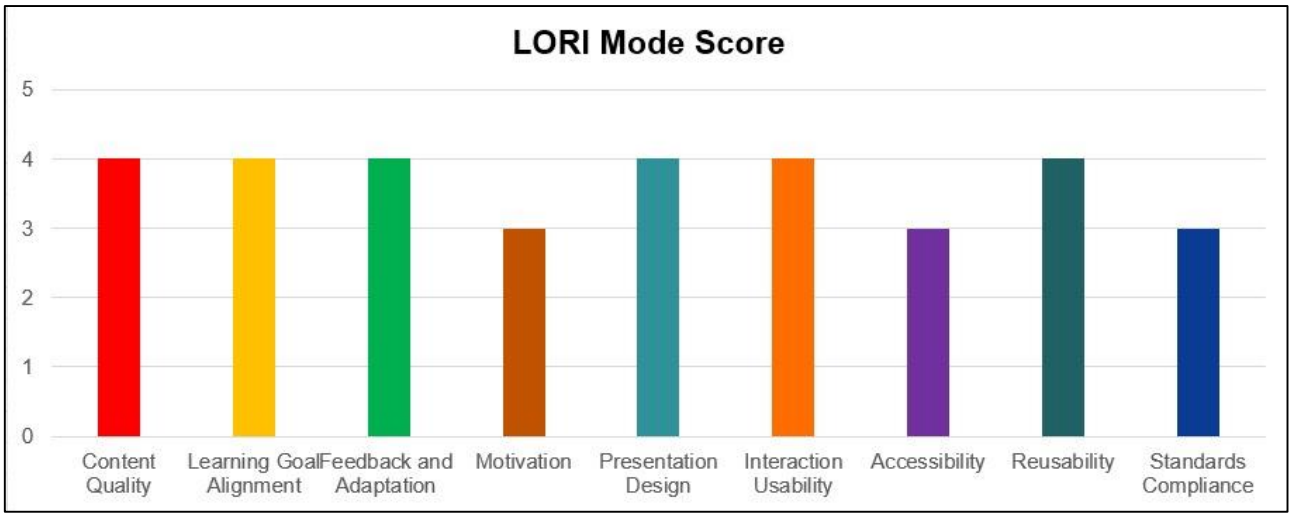
Fig. 3 PLIDe evaluation session with experts (a) Graphic Design Expert; (b) Multimedia Creative Expert; (c) Information Technology Lecturer; (d) *Designer expert*

Most lecturers commented on the button labels, colour selection, font size, adding more learning materials, attractive animation and proper sound selection for the PLIDe application, suggesting areas for improvement.

Additionally, 108 students responded to the usability survey. The CSUQ questionnaire was administered using Google Forms distributed through WhatsApp groups to final-year IT diploma students at UTHM Pagoh campus. This survey aimed to evaluate four main aspects: system usefulness, information quality, interface quality, and overall usability. These categories are identified as System Usefulness (SYUSE), Information Quality (INFOQUAL), Interface Quality (INTERQUAL), and Overall Usability (OVERALL). The average CSUQ scores for these categories are presented in Fig. 4 (a). Additionally, the usability survey indicates high SYSUSE score which can be attributed to the system's efficiency, user-friendliness, relevance, reliability, and positive impact on productivity. Despite receiving a commendable score of 6.0, there is still room for improvement to better align with user expectations. INFOQUAL also received an average score of 6.0, indicating users find the information provided by the system to be satisfactory. INTERQUAL received the highest score at 6.2, indicating strong user satisfaction with the system's interface, finding it intuitive and easy to navigate. OVERALL score averaged 6.1, reflecting a high level of satisfaction across all evaluated dimensions. Fig. 4(b) illustrates the LORI Mode Score, which consists of 9 items: Content Quality, Learning Goal Alignment, Feedback and Adaptation, Motivation, Presentation Design, Interactive Usability, Accessibility, Reusability, and Standards Compliance.



(a)



(b)

Fig. 4 presents (a)CSUQ Average Score; (b) LORI Mode Score

Most items achieved a mode score of 4, including Content Quality, Learning Goal Alignment, Feedback and Adaptation, Presentation Design, Interactive Usability, and Reusability, while the remaining three items scored 3.

3.2 Discussion

This feasibility survey indicates that most of the students at UTHM, Pagoh, have an intermediate level of proficiency in programming subjects. The usability survey responses indicated that most student preferred visualisation of programming education material supported with hands on exercise to practice their mastery of programming skills. Reading and writing notes and listening to lectures are less favoured by the respondent probably due to their early exposure on digital devices which shorten their attention span in traditional learning approach. Hence, more engaging approach such as hands on and visualisation are best in delivering leaning content to 21st century students nowadays. The results of the three surveys suggest that the PLIDe application is well-received by users, easy to use, efficient, and satisfactory. Although there are some areas for improvement, particularly in the quality of the user interface and the clarity of error messages, the PLIDe application is well received by users.

4. Conclusion

Python Programming Language Instructional Design (PLIDe) is designed as a programming education instructional design with a flexible learning style. Through various learning resources and assessments, PLIDe

aims to support effective learning experiences. Three online surveys were conducted before and after the application was fully functional to evaluate the usability, pedagogical and technical quality of PLIDe features and content. Although PLIDe is well received by users, it could be improved in terms of the user experience. In conclusion, it is recommended to refine PLIDe's interface to enhance usability and ensure alignment with user expectations. However, despite these aspects that require enhancement, PLIDe demonstrated its potential to support effective learning environments for Python programming.

5. Online License Transfer

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Hazwani Rahmat, Muhammad Noor Azmeer Abdul Halim;* ***data collection:*** *Hazwani Rahmat, Haikal Aizuddin Nasruddin, Muhammad Noor Azmeer Abdul Halim, Nur Liyana Insyirah Mohd Barsrah;* ***analysis and interpretation of results:*** *Hazwani Rahmat, Nur Liyana Insyirah Mohd Barsrah;* ***draft manuscript preparation:*** *Hazwani Rahmat, Nur Liyana Insyirah Mohd Barsrah, Haikal Aizuddin Bin Nasruddin. All authors reviewed the results and approved the final version of the manuscript.*

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