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SIAGA in Deep Learning Curriculum Design: Instructional Differentiation Strategies to Detect Early Reading Ability

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ABSTRACT

The low initial reading ability of students in Bali is often due to uniform teaching and a lack of early detection of individual learning disabilities. This study aims to develop and test the effectiveness of a Deep Learning-based SIAGA (Early Reading Disorder Identification System) application to support instructional differentiation strategies. By using the Rapid Application Development (RAD) method. The research population is elementary and secondary school students in Buleleng Regency, Bali, and the research sample was taken by a purposive sampling technique. The data analysis technique is to measure the average results of UEQ, benchmarks, and comparative test results. The results of the test on 100 teachers showed that SIAGA had an identification accuracy rate of 96%, far exceeding the manual method, which only reached 42%. In terms of usability, this application obtained a System Usability Scale (SUS) score of 82.35 (categorized as Excellent) and an evaluation of the User Experience Questionnaire (UEQ), which shows excellence in terms of efficiency and novelty. This study concluded that SIAGA was effective in reducing identification time from 47.2 minutes to 14.6 minutes per 10 students, while providing an accurate data foundation for teachers to implement differentiated and targeted learning interventions to detect students' early reading ability.

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1. INTRODUCTION

Reading from an early age is the first step that must be accepted by children to improve language development achievement in childhood, involving auditory and visual activities (Ganarsih et al., 2022; Lane et al., 2022; Putu et al., 2022). Low early reading ability in elementary school students in Bali, where many students still have difficulty recognizing letter symbols and arranging syllables phonetically. Difficulty reading early is difficulty recognizing letters (Majorano et al., 2021). There are students who do not know some letters well or even most of the letter forms (Futri et al., 2025; Sepyantari et al., 2021). These constraints are often triggered by the use of uniform learning methods that fail to account for the diversity of students' local cognitive styles and linguistic backgrounds (Darma et al., 2024; Miratunnisa et

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al., 2025; Risna & Sari, 2025). As a result, there is a wide gap between the demands of the standard curriculum and actual learning readiness in the field, where conventional classical teaching fails to facilitate students who have slower learning speeds or mild dyslexic barriers (Wahyuni et al., 2025).

This gap is emphasized by the lack of integration of intelligent technologies capable of automatically adapting material in the classroom (Lestari et al., 2025). Teachers still have difficulties in operating technology independently, have not fully mastered IT, have limited time to develop learning media, and have difficulty choosing media that suits learning conditions (Scott, 2025)). The dominant media used by teachers is only videos accessed from youtube and book-based as a learning resource So far, digital learning tools are still static and have not been able to present personalized interventions (Icahaya et al., 2024). Although there have been many applications to improve reading skills that have been applied, the reading ability of Indonesian children has not been maximized (Suziman et al., 2026).

Therefore, a study was conducted that aimed to analyze the application of SIAGA application capabilities in Deep Learning Curriculum Design: Instructional Differentiation Strategies to Detect Early Reading Ability. Novelties in this study lies in the application of SIAGA (Early Identification System for Reading Disorders) which is in collaboration with the design of the Deep Learning curriculum. This is because the successful implementation of the Deep Learning curriculum is inseparable from the readiness of the education ecosystem, such as teachers' digital competence, the availability of infrastructure, and inclusive education policies for smart technology. Therefore, synergy between technology developers, educational institutions, and the government is essential to ensure that the use of this technology can run optimally and sustainably (Ginting, 2025; Qur et al., 2025). Theoretically, this approach is strongly supported by Vygotsky's Social Constructivism Theory, specifically the concept of the Proximal Development Zone (ZPD. The zone where learning is most effective occurs with guidance, or often referred to as scaffolding (Zaretsky, 2021)). Where the SIAGA application acts as a digital skills scaffolding that helps students move from actual skill level to potential level. In addition, Carol Ann Tomlinson's Theory of Instructional Differentiation integrated into the Deep Learning curriculum provides the basis that learning effectiveness will increase significantly when learning content, processes, and products are tailored to students' readiness and learning profiles (Trisnantari & Dirgantoro, 2026).

In addition, the application of the SIAGA Application as an assessment for learning and reflective teaching is an important element. Formative assessments provide teachers with real-time feedback on the extent to which students understand concepts, while teacher reflection on learning practices allows for continuous improvement. Formatative assessments provide real-time feedback for teachers regarding the extent to which students understand concepts (Qur et al., 2025; Sadiq & Alimuddin, 2025). Meanwhile, the use of technology integrated into the Deep

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Learning curriculum here serves to automate profile mapping so that teachers can provide targeted interventions. Integration of the SIAGA application in the curriculum *Deep Learning* This is expected to be able to change the initial reading learning pattern from a linear model to a responsive circular model. By leveraging artificial intelligence to support differentiation, specific barriers found in students in Bali can be overcome through more contextual and interactive materials. This is not only aimed at increasing literacy scores, but also to build students' self-efficacy from an early age in mastering basic skills that are the gateway to all future mastery of science

2. METHODS

This research method uses the Rapid Application Development (RAD) development model, which consists of four main stages to ensure the speed and accuracy of the SIAGA application function. The first stage is Condition Planning (*Requirements Planning*), where an in-depth analysis of the literacy problems of elementary school students in Bali is carried out, and the identification of system needs to detect early reading disorders. The research population is teachers, elementary school students, and junior high school students in Buleleng Regency. The research sample was taken by the purposive sampling technique. The data analysis technique is to measure the average results of UEQ, benchmarks, and comparative test results.

The researcher identified the main purpose of the application as a curriculum support instrument that is able to map student obstacles automatically before proceeding to the second stage, namely the Design Workshop (*RAD Design Workshop*) (Prasepta et al., 2025). In this phase, user engagement is essential through the process of designing an iterative application prototype, where the design of the interface and the flow of logic Deep Learning tested and improved repeatedly based on the input of educational practitioners to ensure ergonomic aspects and instructional effectiveness. Entering the third stage, namely Construction (Construction), the research focus shifted to technical development, which included coding deep learning algorithms, integration of different reading material data banks, and continuous unit testing. This process is carried out in conjunction with the improvement of the module based on the simulation results until the application is considered stable and functional for use on a wider scale. (Aulianita & Mukhayaroh, 2025). The last stage is the Solution (*Cutover*), which involves the application of SIAGA directly in elementary and junior high school settings to test the effectiveness of instructional differentiation strategies in improving students' early reading skills. Through this rapid feedback-based RAD cycle, the resulting application is not only technically sophisticated but also highly relevant to the pedagogical needs of teachers and the learning characteristics of students in the field. The design is briefly presented in Figure 1.

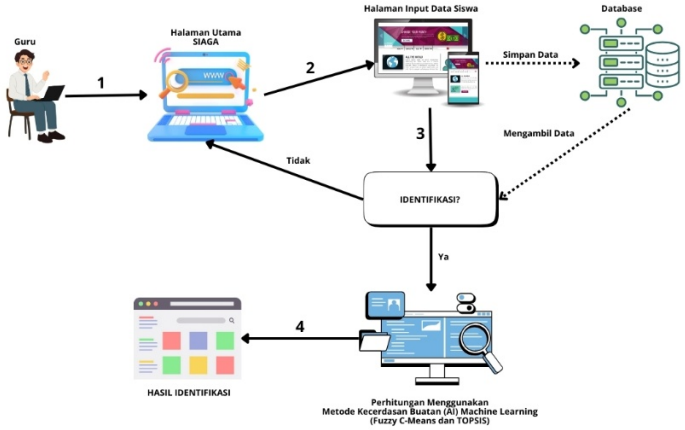

Figure 1. SIAGA Design

Through Figure 1. He explained that teachers access the system through the SIAGA website page online. Before carrying out the identification process, teachers are required to enter student data along with reading ability scores according to the predetermined assessment instruments. If the teacher selects the "Identification" menu, the system will display the identification page. On the other hand, if the menu is not selected, the teacher will remain on the main page of SIAGA. The identification process is carried out automatically by the system. The results of the identification were in the form of grouping students with low reading ability, then a list of names of students in groups was displayed in order based on the lowest level of reading ability.

Thus, the results of this identification allow teachers to provide more appropriate handling, both through the provision of remedial materials and the application of teaching methods that are in accordance with the needs of students.

3. RESULTS AND DISCUSSION

SIAGA is developed using the Rapid Application Development (RAD) software development method, with the following stages:

Figure 2. Rapid Application Development (RAD) Method

1. Requirements Planning: This stage involves creating a list of system requirements, both functional and non-functional, to achieve system development goals.
2. User Design: This stage involves researchers designing system interfaces (front-end) using the Bootstrap framework.

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3. Construction: This stage involves developing a system based on the designed interface. For the back-end, the system is developed using the PHP programming language and MySQL database.
4. Cutover: This stage involves testing the functionality of the system using the black box testing method. The goal is to ensure that all functions meet the predefined functional specifications.
5. Maintenance: This stage involves performing periodic system maintenance to fix program bugs. This ensures the long-term usability of the system.

The achievement of the level of technological readiness in the development of the SIAGA website is shown through the implementation of validation tests in the relevant environment. The trial involved 100 elementary school teachers under the auspices of the Buleleng Regency Education Office. To measure user experience, the User Experience Questionnaire (UEQ) instrument is used, which is specifically designed to evaluate the quality of the user's interaction experience with a system. The UEQ consists of six key assessment indicators: Appeal, Intelligence Efficiency, Reliability, Stimulation, and Novelty (Profita et al., 2022). Through these six indicators, a comprehensive picture of the level of satisfaction and comfort of users in utilizing the SIAGA website is obtained. Based on the questionnaire calculations, the data collected provides detailed information on the main aspects that affect the user experience, as presented in Table 4, thus serving as a reference for system improvement.

Table 1. UEQ Analysis Results

Confidence interval (p=0.05) per scale					
Scale	Mean	Std. Dev.		Confidence	Confidence intervals	
Attraction	1,697	1,052	00	0,206	1,491	1,903
Intelligence	1,878	0,725	00	0,142	1,735	2,020
Efficiency	1,900	0,802	00	0,157	1,743	2,057
Reliability	1,575	0,827	00	0,162	1,413	1,737
Stimulation	1,700	0,575	00	0,113	1,587	1,813
Novelties	1,618	0,776	00	0,152	1,465	1,770

Table 4 shows the mean, standard deviation, number of respondents (N = 100), and confidence interval for each dimension of UEQ at a significance level of 95%. The appeal showed that respondents generally found the app quite attractive, despite significant differences of opinion (Std. Dev > 1). Intelligence shows that

users find this app easy to understand and learn. The interval was relatively narrow, suggesting that respondents' assessments were consistent. Efficiency shows that the application is considered efficient in supporting users, requiring relatively little time and effort to complete tasks. Dependencies show that respondents consider the app to be quite reliable, but variations in perception are still visible. This shows that some respondents feel that the system is not completely stable/consistent. Stimulation shows that the app provides motivation and a pleasant experience for the user.

The relatively narrow interval suggests that respondents' perceptions tend to be consistent. Novelty shows that the app is considered to have elements of novelty and innovation, although some respondents still consider it average. UEQ also conducts benchmark evaluations to get an idea of the level of user satisfaction when using the SIAGA system. Comparison with benchmark results shows that most of the benchmark interval values categorized as Good. There are two scales for the Excellent category, where the categories are divided into Excellent, Good, Above Average, Below Average, and Poor (Amanda et al., 2024). Table 2 shows the results of the evaluation of the SIAGA benchmark.

Table 2. Results of the SIAGA benchmark evaluation

Scale	Red	Comparison with benchmarks	Interpretation
Attraction	1.70	Good	10% better results, 75% worse results
Intelligence	1.88	Good	10% better results, 75% worse results
Efficiency	1.90	Awesome	In the range of 10% of best results
Reliability	1.58	Good	10% better results, 75% worse results
Stimulation	1.70	Good	10% better results, 75% worse results
Novelties	1.62	Awesome	In the range of 10% of best results

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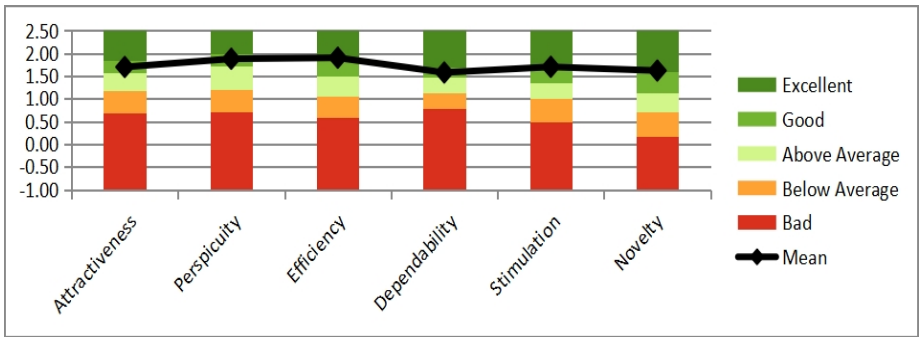

Figure 3. Comparison Results with Benchmark Scales

Based on Table 2 and Figure 3, it can be seen that the system achieves good results on most of the assessment scales. The Efficiency and Newness scales received the highest average scores of 1.90 and 1.62, respectively, in the Excellent category, which means they are in the top 10% of results. This shows that the system is considered efficient in use and capable of providing a relevant aspect of novelty for users.

Meanwhile, the Attraction, Attractiveness, Dependence, and Stimulation scale is in the Good category, with average scores of 1.70, 1.88, 1.58, and 1.70, respectively. Interpretation of these results shows that on these four scales, 10% of the measurement results are better, and 75% of the results are worse. As such, it still has an advantage over most other systems used for comparison.

However, some aspects still need to be considered. The Dependability Scale has the lowest average score of 1.58, although it falls into the Good category. Therefore, the SIAGA application needs to strengthen the reliability aspect of its system in order to more consistently provide stable and reliable services to users. In addition, the Attraction and Stimulation aspects, which achieved the same average score (1.70), can also be improved, for example, through improved user interfaces, more attractive visual design, and the addition of interactive features to increase user engagement and appeal.

Overall, the results of the benchmark evaluation showed that the system was at a good to very good level, with the dominance of the Good and Very Good categories. This shows that the system has a solid foundation of quality, but there is still room for improvement, especially in terms of reliability, visual appeal, and user stimulation, to further optimize the user experience.

Achievements Technology Readiness Level 6 on the SIAGA website, namely the implementation test in the relevant environment, is shown by providing access to the SIAGA website to 100 elementary and junior high school teachers under the auspices of the Buleleng Regency Education Office. The instrument used is the System Usability Scale (SUS) to determine the overall usability of the platform (Mansur & Azzahra, 2023). The test results showed that the SIAGA website is suitable for the early identification of reading difficulties in elementary and junior high school students.

An average SUS score of 82.35 indicates that the system has a high quality of usability. This score places SIAGA in the Excellent category according to SUS interpretation standards, confirming that users find the system convenient and easy to use. This high score reflects that users can understand the flow of use, navigation, and complete identification tasks effectively without encountering significant obstacles. Thus, SIAGA not only meets basic usability standards but also provides an optimal and efficient user experience and supports the successful early identification of reading disorders in schools.

The effectiveness of the SIAGA application is tested using SIAGA instrument documents as the main guide for data analysis. This test aims to compare the performance of manual (conventional) reading disorder identification methods with SIAGA application-assisted methods. The main focus of the test includes four aspects: time efficiency, difficulty of use, teacher confidence in the identification results, and accuracy of the identification results.

Table 3. Results of Manual and SIAGA Method Comparison Test

Aspects Assessed	Guide	SIAGA
Average Time / 10	47.2 minutes	14.6 minutes
Difficulty level	Difficult	It's easy
Confidence level	Lack of confidence	Very confident
Accuracy Rate	42%	96%

Based on all the test results, it can be concluded that the SIAGA application consistently shows superior performance compared to manual identification methods. SIAGA not only significantly improves time efficiency, but also reduces the level of difficulty of use and increases teachers' confidence in the identification results.

In addition, the high level of accuracy suggests that SIAGA has great potential as an objective and reliable tool for early identification of reading disorders. Thus, SIAGA can support teachers in conducting early detection faster, more accurately, and based on data, thus enabling earlier and more effective learning interventions.

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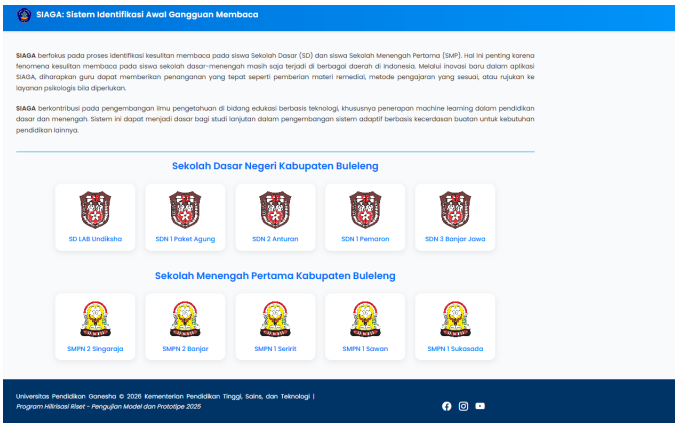

Figure 4. SIAGA Application

The application of SIAGA in Deep Learning-based curriculum design shows that the synergy between artificial intelligence technology and the right pedagogical strategies can fundamentally transform basic literacy learning. The use of the Rapid Application Development (RAD) method is key as it allows for quick synchronization between teacher and student needs and the technical features of the application through iterative cycles that ensure each differentiation module is clinically tested before widespread implementation. Within this framework, the application serves not only as a static medium but as an intelligent assistant capable of automatically mapping the learning profile of students, allowing curriculum design to move adaptively according to individual progress without ignoring national achievement standards.

The application of differentiation strategies in this application is strongly supported by Vygotsky's Social Constructivism Theory, where the SIAGA application acts as a digital scaffolding in the Proximal Development Zone (ZPD). Learning media can be used to help students overcome early reading barriers through measurable support (Kusmaryono et al., 2021). In addition, Carol Ann Tomlinson's Theory of Instructional Differentiation provides the basis that learning effectiveness increases when learning content, processes, and products are tailored to student readiness (Ningtyas & Lestari, 2024). In the SIAGA application, this is realized through automatic adjustment of the difficulty level of words and phonemes based on Deep Learning algorithms. The success of the RAD method in facilitating the development of these features is also in line with Cognitive Load Theory, where design iterations ensure the application interface minimizes distraction and maximizes students' focus on the phonetic elements being learned (Chen et al., 2023; Evans et al., 2024)

More broadly, the effectiveness of this system is also based on the Self-Regulated Learning (SRL) Theory, where the instant feedback provided by the SIAGA application encourages students to self-

correct and build self-efficacy in reading (Keung & Cheng, 2025; Rodríguez-Gómez, 2025). By leveraging artificial intelligence to support differentiation strategies, specific barriers experienced by students in Bali such as native language disorders or mild dyslexia can be detected early through in-depth data processing. As a result, the integration of the SIAGA app into the curriculum creates an inclusive

ecosystem that not only improves technical literacy skills but also provides equitable access to education for each student based on their unique cognitive characteristics (Forn et al., 2022).

4. CONCLUSION

Based on the results of development and testing, it can be concluded that the SIAGA (Early Reading Disorder Identification System) website has been successfully realized, especially in the deep learning curriculum as a prototype of a web-based application that is able to identify reading problems in elementary school students automatically through the formation of clusters. Although there are some aspects of limitations, such as attractiveness and stimulation, that can still be improved to make the system more stable and attractive to users. The recommendation for further research is to apply the principle *of User-Centered Design* (UCD), which is more child-friendly (*child-friendly interface*) by optimizing visualization, animation, and voice guidance (*voice guidance*) to provide more interactive sensory stimulation.

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