ENHANCING DIGITAL LITERACY AND TEACHER-PRENEURSHIP THROUGH A CRITICAL PEDAGOGY-BASED TRAINING PLATFORM

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Abstract

This study developed a digital learning platform to enhance digital literacy and entrepreneurial spirit among elementary school teachers in Indonesia, using a critical pedagogy approach. The study followed a design-based research (DBR) method, consisting of analysis, design, development, and evaluation. A four-week training program was conducted with 238 teachers. The results of expert validation confirmed that the application, based on critical pedagogy, was effective because it promotes active engagement and reflective learning. Trial results showed a significant improvement in digital literacy, with positive ranks averaging 52.42 and negative ranks at 28.50, demonstrating an increase in digital skills. Notably, 87% of participants improved in critical content evaluation, while 79% enhanced their digital collaboration skills. The study's impact extends beyond digital literacy, fostering a critical awareness of technology's socio-cultural implications and inspiring teacher-led digital entrepreneurship, such as developing educational content and digital products. Because the integration of critical pedagogy and gamified micro-learning encourages active participation, it has proven effective despite rural infrastructure challenges. This study highlights the importance of contextually designed training programs that emphasize agency, critical reflection, and collaboration to bridge the digital divide and drive educational innovation in underserved areas.

Keywords: Critical pedagogy, DIAJARDEUI, Digital literacy, Teacher-preneur, Teacher training.

1.Introduction

Digital literacy is a crucial competency for educators in the technological era, especially in Indonesia, where internet penetration has reached 77.02%, yet the digital literacy index remains moderate (3.49/5) [1-4]. This relates to the need for technology to increase the education level [5-9]. Despite widespread access, urban-rural disparities persist, with only 45% of rural teachers possessing sufficient digital skills compared to 68% in urban areas [10, 11]. This highlights the need for contextualized training programs to enhance teacher digital literacy, particularly in underserved regions.

Beyond digital literacy, teacher-preneurship is key to educational transformation in Indonesia. While 21% of the population engages in entrepreneurial activities [12], only 30% of teachers demonstrate entrepreneurial skills, such as curriculum innovation and technology-based resource management [13]. Teacher-preneurs play a pivotal role in developing innovative solutions to local educational challenges [14].

Integrating digital literacy and teacher-preneurship into teacher training presents a strategic solution. The critical pedagogy approach, which fosters critical reflection on technology use and teacher agency, has proven effective in enhancing both digital competence and entrepreneurial skills [15]. Research indicates that teachers applying critical pedagogy are more adept at identifying algorithmic bias in educational platforms and creating empowering learning content [16, 17].

Table 1 presents previous studies on educator digital literacy and teacher-preneurship aimed at improving teaching quality and expanding access to educational content. However, no existing online training program fully incorporates a critical pedagogy approach. This study aims to develop an application-based training program integrating critical pedagogy to enhance digital literacy and teacher-preneurship, focusing on elementary school teachers in Indonesia. Using design-based research, this study introduces a novel critical pedagogy-based learning platform, fostering critical thinking, adaptability, and collaboration within a digital learning environment.

Table 1. Previous research.

No.	Title	Ref.
1.	Digital Pedagogy as an Effort to Improve the Competence of 21st Century Teachers	[18]
2.	Digital literacy to improve teacher competence in the era of the Industrial Revolution 4.0.	[19]
3.	Utilization of e-learning for educators in the digital era 4.0.	[20]
4.	Optimizing digital literacy to achieve quality education towards sustainable development goals (SDGs) 2030.	[21]
5.	The Influence of Digital Literacy on Teachers' Pedagogical Competence.	[22]
6.	Improving Teacher and Education Personnel Competence Through Digital Profile Builder-Based Teacherpreneur Training.	[23]
7.	Becoming a better teacher through online teacherpreneurship? Factors influencing online teacherpreneurs' perceived gains in teaching practice.	[24]

2. Literature Review

2.1. Digital literacy

Digital literacy refers to an individual's ability to find, evaluate, utilize, share, and create content using information and communication technologies, particularly the Internet. Beyond technical proficiency, it requires effective, responsible, and critical use of technology across academic, professional, social, and personal contexts [25].

Digital literacy includes information skills applied to text and multimedia, with increasing responsibilities as users access vast amounts of information [26]. Some researchers [27] described digital literacy as a "toolbox of skills" applicable to academics, careers, and everyday life. More than just knowledge, it involves applying skills to achieve goals, engage in society, and maximize personal potential [28, 29]. It enables individuals to navigate complex digital landscapes, communicate effectively, collaborate, and express creativity [30].

Figure 1 illustrates Renée Hobbs' four digital literacy competencies, emphasizing a multifaceted approach:

(i)   Sharing and Using Information – Involves accessing, analysing, evaluating, creating, and sharing information responsibly, extending traditional information literacy to the digital realm [31].
(ii) Learning and Connecting with Others – Focuses on using digital tools to connect, collaborate, and learn, emphasizing the social and participatory aspects of digital literacy [32].
(iii) Civic Engagement – Highlights the role of digital tools in civic participation and social change, including discussions, advocacy, and democratic participation [33].

Self-Expression and Creativity – Encourages creative expression, storytelling, and identity formation through digital media, especially among young content creators [34].

Fig. 1. Digital literacy indicators.

2.2. Correlation of digital literacy with critical pedagogy

Critical pedagogy challenges power structures in education through reflective dialogue [35]. In the digital era, it encourages teachers to analyses algorithmic bias in educational platforms [36], create empowering content that positions students as active knowledge producers [37], and move away from passive, banking-style education models [38].

Digital literacy extends beyond technical skills to critical evaluation and ethical use of technology [39]. Research suggests that teachers applying critical pedagogy are more likely to identify and challenge unfair practices in digital platforms [16]. Some researchers [40] further emphasized the need for learning designs that enable students to become knowledge creators rather than passive consumers.

2.3. Integration of technology in education

Technology integration in education has been widely researched [41], but its effectiveness depends on how critically and effectively it is applied [42]. Some researchers [43] highlighted the need for strong pedagogical foundations to ensure technology enhances learning. Teacher training is crucial in helping educators effectively integrate technology into their teaching [44].

TPACK (Technological Pedagogical Content Knowledge) is a key framework supporting this integration, which emphasizes the importance of aligning technology, pedagogy, and content knowledge in education [45].

2.4. Digital literacy and the digital divide

Despite its importance, digital literacy gaps persist between urban and rural areas [46]. Studies show that teachers in rural areas often have limited access to technology and training [10, 47]. Addressing this divide requires a holistic approach, including infrastructure development, teacher training, and locally relevant content [48]. Research further suggests that digital literacy should not only focus on technical skills but also on critical thinking and ethical technology use [49].

2.5. Microlearning and gamification in education

Microlearning and gamification have emerged as effective teacher-training strategies [50]. Studies indicate that gamification enhances engagement and motivation, making learning more interactive and enjoyable [51]. Microlearning improves knowledge retention, especially in teacher training contexts [52].

Successful implementation of gamification requires thoughtful design [53], ensuring alignment with learning objectives. Research also highlights that well-designed gamification improves cognitive and social skills [54].

2.6. Collaboration and learning communities

Collaboration and learning communities play a key role in teacher development [55]. Studies suggest that participation in professional learning communities improves teaching skills and knowledge [56]. Teacher collaboration enhances teaching effectiveness [57], while a collaborative culture fosters innovation and adaptability in education [58]. Additionally, research suggests that teachers engaged in collaborative networks develop stronger pedagogical and professional skills [59].

2.7. Teacher-preneurship

The teacher-preneur concept combines entrepreneurial spirit with pedagogical expertise, allowing teachers to become adaptive curriculum designers, digital content creators, and educational innovators [60]. Previous studies showed that teacher-preneurs are more likely to integrate technology effectively into learning [61, 62]. Research highlights that entrepreneurial educators drive educational transformation, particularly in the digital space [63, 64]. Developing teacher-preneurship skills through targeted training can equip educators for 21st-century challenges [65]. Table 2 presents teacher-preneur competency indicators, highlighting the integration of pedagogical expertise and entrepreneurial skills to foster educational innovation.

Table 2. Digital competencies of teacherpreneurs.

Indicators	Descriptions
Innovation and Creativity	Ability to develop and implement innovative teaching methods, create engaging learning resources, and adapt to evolving educational needs [66, 67].
Digital Literacy	Proficiency in using technology for educational purposes using digital tools for instruction, communication, collaboration, and professional development [68].
Curriculum Design and Development	Deep understanding of curriculum design principles and can create or adapt resources to meet specific learning objectives [69].
Entrepreneurial Mindset	Demonstrate initiative, take risks, face challenges, seek opportunities for growth and improvement in the field of Education, and involve a focus on continuous adaptive learning [70].
Business Acumen	Basic business skills to manage projects, engage in marketing expertise, manage financial budgets, or launch educational ventures [71].
Collaboration and Networking	Build relationships with educators, and professionals, share resources, gain support, and expand your impact. This can be done by participating in online communities, attending conferences, or collaborating on projects [72].

3. Method

This study employed a design-based research (DBR) approach to develop and evaluate the DIAJARDEUI application, which serves as a teacher-preneur training platform for elementary school teachers by integrating a critical pedagogy approach. Figure 2 illustrates the steps involved in the DBR process, which consists of four phases: analysis, design, development, and evaluation.

At the analysis stage, a needs assessment was conducted to identify the challenges teachers face in digital literacy and entrepreneurial competencies. Surveys and interviews with elementary school teachers were used to understand their perceptions, experiences, and expectations regarding teacher-preneur training. The findings highlighted the need for an application that provides structured, collaborative, and experiential learning to support professional development. Teachers indicated that existing training programs lacked interactivity, application-based learning, and ongoing mentoring, reinforcing the necessity of a practice-oriented digital training platform.

During the design stage, the application framework was developed based on the principles of critical pedagogy, which emphasizes active learning, problem-solving, and reflective dialogue. The learning experience was structured to facilitate teacher agency, ensuring that teachers are not passive recipients of information but actively engaged in analysing, discussing, and applying entrepreneurial concepts. The application was designed to include key features such as adaptive learning, which personalizes content based on the user's proficiency level, problem-based video modules, which provide real-world entrepreneurial scenarios, and community discussion spaces, which allow teachers to exchange insights and collaborate with peers. The design also incorporated interactive assessments and feedback mechanisms to enhance engagement and knowledge retention.

At the development stage, the application was built based on the established design framework. The DIAJARDEUI platform was programmed to allow teachers to navigate content flexibly, select their learning pathways, and participate in interactive discussions. The integration of AI-driven hypercontent adaptation ensured that learning materials were personalized to suit individual teacher needs. The application underwent pilot testing, where a small group of teachers used the platform and provided feedback on usability, functionality, and learning effectiveness. Adjustments were made based on user input to optimize the platform's design and ensure a seamless learning experience.

The evaluation stage focused on assessing the effectiveness of the application in improving digital literacy and teacher-preneurship competencies. A quasi-experimental design was used, where a training group of 200 teachers participated in a four-week training program using the DIAJARDEUI application, while a control group of 38 teachers received traditional professional development without digital integration. Pretest and posttest assessments were conducted to measure improvements in digital literacy skills, entrepreneurial mindset, and teaching innovation practices. The Wilcoxon signed-rank test was used to analyses statistical differences between pretest and posttest scores, confirming whether the application had a significant impact on learning outcomes. Detailed information regarding statistical analysis is explained elsewhere [73 - 75].

Qualitative data were collected through open-ended survey responses, discussion transcripts, and interviews, allowing researchers to analyses teacher perceptions and engagement with the application. Thematic analysis was used to extract key insights, identifying areas where the platform succeeded and where further refinements were needed. In addition to statistical and qualitative evaluations, usability metrics were examined, including time spent on modules, completion rates, and interaction levels within discussion forums, to assess engagement and overall learning effectiveness.

This research followed ethical considerations by obtaining informed consent from participants, ensuring data confidentiality, and complying with institutional research ethics guidelines. The findings from this study provide valuable insights into how digital learning platforms can be designed and implemented to support teacher-preneur training, ensuring that teachers develop critical digital literacy skills and entrepreneurial competencies. By integrating critical pedagogy principles into the DIAJARDEUI application, this study contributes to the advancement of digital education, offering a contextually relevant and practical training solution for teachers in the modern educational landscape.
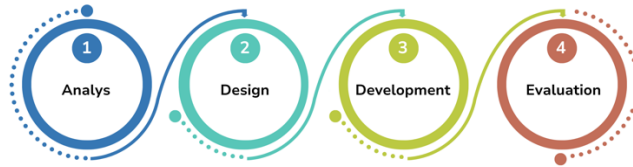

Fig. 2. Design-based research steps.

4. Results and Discussion

4.1. Analysis of teacher-preneur training needs

Figure 3 presents the results of a teacher-preneur training survey conducted among 30 teachers. The findings indicate that 70% of respondents support integrating entrepreneurship into the teaching profession, while 25% remain hesitant, and 5% oppose the idea. This suggests that most teachers recognize the importance of entrepreneurial skills in modern education but require further clarification on its implementation because they lack exposure to structured training programs on teacher-preneurship.
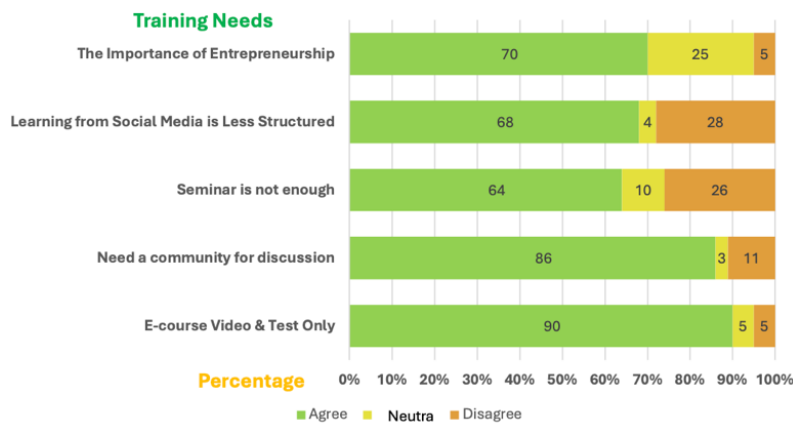

Fig. 3. Results of needs analysis survey.

Additionally, 68% of teachers feel that entrepreneurship learning through social media lacks structure, which aligns with [76], highlighting that social media often lacks content curation and pedagogical intent because it is not specifically designed

for structured learning. Similarly, 64% of teachers believe that seminars alone are insufficient for entrepreneurial training, reinforcing [65] findings that traditional lecture-based approaches fail to develop practical skills because they do not provide ongoing mentoring, feedback, or real-world application.

Notably, 86% of respondents expressed a strong need for discussion communities to facilitate knowledge exchange and collaboration because interaction with peers enhances understanding and skill application, as supported by [77], which emphasizes that learning occurs effectively through social interactions and communities of practice. Moreover, 90% of teachers criticized e-courses that rely solely on videos and quizzes, supporting [78], giving arguments that passive online learning lacks interactivity and problem-solving engagement because it does not allow learners to apply knowledge in meaningful contexts.

These results highlight the urgent need for a structured, practice-based, and community-driven teacher-preneur training model because conventional training approaches fail to equip teachers with entrepreneurial skills effectively. The model should integrate blended learning, reflective discussions, and experiential learning approaches [79] to ensure sustainable knowledge transfer and skill development.

4.2. Design of training applications based on critical pedagogy

Figure 4 presents the application, designed to integrate critical pedagogy principles with technological tools to enhance learning outcomes [80]. This framework encourages problem-based learning, allowing educators to analyses real-world issues within the teacher-preneur context because applying theoretical knowledge to practical situations deepens understanding and engagement.
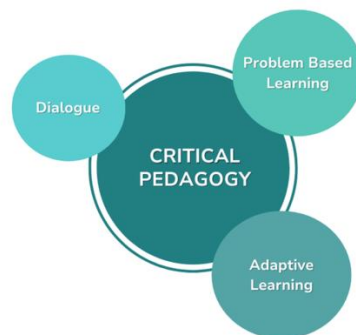

Fig. 4. Critical pedagogy concepts in application.

A key feature of the application is adaptive learning, which tailors content based on user proficiency levels because personalized learning experiences optimize knowledge retention and skill acquisition [81]. Additionally, collaborative discussions are incorporated to facilitate peer validation, critical thinking, and collective knowledge building because group learning enhances comprehension through diverse perspectives [82].

The application's discussion platform serves as a dialogue space where users can verify and challenge their understanding, aligning with [83] on education as a practice of liberation through discussion because active engagement in critical

dialogue encourages deeper reflection and independent thought. This interaction not only enhances comprehension but also strengthens collaboration skills essential for entrepreneurial success.

Figure 5. Shows the flowchart of the DIAJARDEUI application which integrates a critical pedagogy approach to teacher-preneur training.
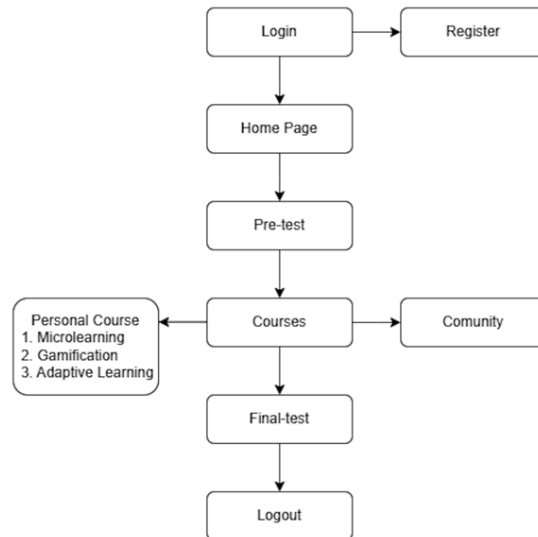

Fig. 5. Flow chart of the DIAJARDEUI application.
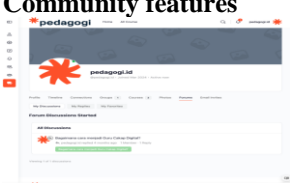
4.3. Development of the application

Table 3 showcases the user experience and interface of the application, which integrates critical pedagogy principles to enhance digital literacy and entrepreneurship.

One notable feature is a hyper-content adaptation, which allows users to select content based on their initial knowledge level, making the learning process more personalized and efficient because learners have diverse backgrounds and require different levels of support [84]. AI-driven features further enhance content organization and motivation strategies because they analyses successful student learning patterns to optimize instructional pathways [85].

The adaptive learning feature adjusts learning pathways dynamically, tailoring content based on user proficiency, similar to adaptive hypermedia systems [86] because personalized learning fosters higher engagement and skill mastery. This approach supports self-regulated learning, enabling users to progress at their own pace, as seen in research on hypermedia-assisted instruction [87].

Interactive quizzes embedded within the platform enhance user engagement by providing real-time feedback, a method proven effective in maintaining attention and reinforcing learning [88] because frequent knowledge checks keep learners actively involved. Research shows that interactive learning tools, such as mid-session quizzes, improve knowledge retention and participation [89, 90] because they break passive learning cycles and encourage reflection.

Table 3. The user experience and interface of the application.

Figure	Function
Hypercontent	The hypercontent feature is a feature that gives users the freedom to choose content according to their initial abilities.
Adaptive Learning	This feature will recommend different learning depending on the level of proficiency the user has achieved while accessing the course.
Interactive Quiz	This feature will appear in the middle of the presentation, to ensure user focus when accessing the material.
Problem-Based Video	Learning content is provided in the form of videos that examine contemporary issues. Train users to critically analyse problems and get used to providing solutions.
Community features	The community feature is a critical dialogue space as a vehicle for the falsification and verification of user knowledge that has been obtained during the course.

Additionally, video-based learning modules covering real-world entrepreneurial challenges encourage critical analysis and problem-solving because visual storytelling and real-life scenarios enhance engagement and knowledge retention [91]. When combined with assessments like reflective exercises, these videos effectively gauge critical thinking skills [92, 93] because learners are prompted to apply concepts in meaningful ways.

The community discussion feature provides a space for critical dialogue, allowing users to debate, validate, and refine their understanding because knowledge construction is most effective in interactive and dynamic environments [91]. This feature promotes peer learning and collaborative problem-solving, ensuring a comprehensive and engaging educational experience [94, 95].

4.4. Effectiveness of teacher-preneur training using the application

We presented the Wilcoxon test results, which analyses the statistical significance of pretest and posttest scores (Z value of -7.830 and Asym. Sig. (2-tailed)). The test results indicate a significance value ($p < 0.001$), which is lower than the alpha threshold (0.05) because the probability of obtaining these results by chance is extremely low. This confirms a statistically significant difference between pretest and posttest scores, rejecting the null hypothesis (H0) in favour of the alternative hypothesis (H1) [96-98].

We also further highlighted that the average positive ranks (52.42) significantly outweigh the negative ranks (28.50) because the posttest scores showed a notable increase, demonstrating substantial improvements in digital literacy and entrepreneurial skills after using the application. This aligns with prior studies on e-learning's role in enhancing digital literacy because structured digital platforms provide more effective learning experiences than traditional methods.

The application's features—adaptive learning, problem-based videos, and critical discussion spaces—are designed to enhance digital literacy and entrepreneurial skills because they align with proven pedagogical approaches [99]. Adaptive learning adjusts the material difficulty to suit user needs because personalized instruction fosters skill retention [99], while problem-based videos encourage real-world problem-solving because experiential learning improves cognitive engagement [100]. The critical dialogue space promotes interactive discussion and peer validation, reinforcing critical thinking skills because learners challenge and refine their understanding through discourse [101].

By integrating these elements, the application supports the development of teacher-preneurship because it empowers teachers to become digital innovators in education [102]. Enhanced digital literacy enables teachers to navigate modern educational challenges because they can effectively integrate technology into their pedagogical practices, ensuring they contribute to improving overall educational quality [103].

5. Conclusion

This study demonstrates that the DIAJARDEUI application, developed using a design-based research (DBR) approach, is an effective platform for enhancing digital literacy and teacher-preneurship among elementary school teachers. By integrating critical pedagogy principles, the application fosters active learning, reflective dialogue, and problem-solving, ensuring that teachers are not passive learners but active participants in their professional development.

The findings highlight the urgent need for structured and interactive teacher-preneur training. The results of the needs analysis confirmed that teachers require practice-based, collaborative learning environments, as conventional training methods (such as seminars and passive e-learning) are insufficient in developing entrepreneurial competencies. The DIAJARDEUI platform addresses this gap by offering adaptive learning, real-world problem-based video modules, and discussion forums, which enhance engagement and knowledge retention.

The effectiveness of the DIAJARDEUI application was validated through pretest and posttest assessments, where statistically significant improvements were

observed in digital literacy and entrepreneurial skills. The Wilcoxon signed-rank test results confirmed a substantial increase in post-test scores, demonstrating the platform's impact on learning outcomes. Furthermore, qualitative data from teacher feedback highlighted the value of interactive learning experiences, reinforcing the importance of digital tools in teacher professional development.

Despite its effectiveness, challenges remain in ensuring broader accessibility and long-term engagement. Future research should focus on refining the application by incorporating AI-driven personalization, deeper integration of gamification, and expanded mentoring features to enhance user experience. Additionally, efforts should be made to scale the platform to reach a wider audience and bridge the digital divide, particularly in underserved areas.

In conclusion, the DIAJARDEUI application serves as an innovative and practical digital learning platform that empowers teachers to develop entrepreneurial skills and digital literacy. By fostering critical thinking, collaboration, and self-directed learning, the application equips teachers with the necessary competencies to adapt to educational challenges and drive innovation in the classroom. This study underscores the importance of contextually designed, technology-enhanced training programs, which are essential for improving teacher quality and promoting educational transformation in the digital era.

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