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BUILDING FUTURE SKILLS THROUGH ONLINE PRACTICE-BASED LEARNING IN DISTANCE LEARNING: EVALUATION WITH CONTEXT-INPUT-PROCESS-PRODUCT-OUTCOME MODEL

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Abstract

The shift toward digital industry has driven higher education to redesign the practice-based learning strategy to align with the demands of future skills. This study aims to evaluate the implementation of Desktop Programming and Computer Network in a distance learning scheme of Information Systems Program Study, using the Context-Input-Process-Product-Outcome model approach. A mixed-methods approach was employed through the questionnaires, analysis from online learning platform activities, and interviews with students and tutors. The results indicate ongoing issues in the aspects of dissemination of communication regarding policy context, limited infrastructure and devices to support online practice-based learning, and low responsiveness of some tutors. However, students who engaged actively in forums and collaborative learning with peers in completing assignments show better learning outcomes and have a higher confidence to face the challenges of the digital workplace. This evaluation model has proven effective in providing a comprehensive picture of the dynamics of practice-based learning implementation, and producing strategic recommendations for curriculum improvement, tutor training improvement, and integration of learning analytics for early detection and intervention. This study highlighting a conceptual and implementation contributions in online practice-based learning model that promoting transformative and technologically adaptive distance education in building students' professional digital competencies.

Keywords: Blended learning, CIPPO model, computer networks, distance education, educational evaluation, future skills, online practice-based learning, programming

Abstrak

Pergeseran menuju industri digital telah mendorong pendidikan tinggi untuk mendesain ulang strategi pembelajaran berbasis praktik agar selaras dengan tuntutan keterampilan masa depan. Studi ini bertujuan untuk mengevaluasi implementasi Pemrograman Desktop dan Jaringan Komputer dalam skema pembelajaran jarak jauh Program Studi Sistem Informasi, menggunakan pendekatan model Konteks-Input-Proses-Produk-Hasil. Pendekatan metode campuran digunakan melalui kuesioner, analisis dari aktivitas platform pembelajaran daring, dan wawancara dengan mahasiswa dan tutor. Hasil menunjukkan adanya masalah yang berkelanjutan dalam aspek penyebaran komunikasi mengenai konteks kebijakan, keterbatasan infrastruktur dan perangkat untuk mendukung pembelajaran berbasis praktik daring, dan rendahnya responsivitas beberapa tutor. Namun, mahasiswa yang aktif terlibat dalam forum dan pembelajaran kolaboratif dengan rekan-rekan dalam menyelesaikan tugas menunjukkan hasil belajar yang lebih baik dan memiliki kepercayaan diri yang lebih tinggi untuk menghadapi tantangan tempat kerja digital. Model evaluasi ini terbukti efektif dalam memberikan

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gambaran komprehensif tentang dinamika implementasi pembelajaran berbasis praktik, dan menghasilkan rekomendasi strategis untuk peningkatan kurikulum, peningkatan pelatihan tutor, dan integrasi analitik pembelajaran untuk deteksi dan intervensi dini. Studi ini menyoroti kontribusi konseptual dan implementasi dalam model pembelajaran berbasis praktik daring yang mendorong pendidikan jarak jauh transformatif dan adaptif secara teknologi dalam membangun kompetensi digital profesional mahasiswa.

Kata kunci: Pembelajaran campuran, model CIPPO, jaringan komputer, pendidikan jarak jauh, evaluasi pendidikan, keterampilan masa depan, pembelajaran berbasis praktik daring, pemrograman

INTRODUCTION

The development of digital technology has driven a major transformation in the education sector, particularly providing hands-on practice learning in higher education for students. This transformation might also lead the higher education in Indonesia to adapt the industrial needs. Information Systems Study Program in an open and distance higher education for example, includes essential courses such as Desktop Application Programming and Computer Network that are fundamental in shaping students' technical competencies for information technology industry. Such practice-based learning in programming equips students with logic, algorithms, debugging, and problem-solving skills, while practice-based learning in computer network train students for comprehension of network architecture using simulation tools, UTP/RJ45 cable installation, and hardware troubleshooting (Lamri, & Lubart, 2023; Mwansa, Ngandu, & Dasi, 2024).

These two courses are important foundations in preparing graduates who can compete in the digital era and industry 4.0, which requires mastery of future skills such as technical skills, collaboration, and learning flexibility (García-Pérez et. al., 2021). Therefore, practice-based learning should integrate with learning of theory and real-world requirements to achieve clear learning objective: a comprehensive learning outcome to an enhanced theoretical comprehension and experimenting with practice skills (Allison, 2022; Eckerdal, Berglund, & Thuné, 2024). Prior studies have shown that the level of student engagement in online practice-based learning using problem-based learning method significantly affects the student motivation to learn more. Online practice-based learning is often individual and does not facilitate collaboration and active learning, even though social skills and teamwork are

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important aspects of work readiness (Alowais et al., 2023; Ateş & Köroğlu, 2024; Erduran & Levrini, 2024; Kotsis, 2024; Ng et al., 2022; Nungu et al., 2023; Ouyang et al., 2023).

A number of studies about the implementation of online practice-based learning in programming or computer network courses include comparative study of the utilization of online programming simulator platforms (Zinovieva, et.al, 2021), automated assessment system for C++ programming course (Barczak, et.al., 2023), using Large Language Model (LLM) as supporting tool for programming courses (Liffiton et al., 2023), evaluation of the utilization of computer networking simulation tools or programming learning tools (Allison, 2022; Mwansa, Ngandu, & Dasi, 2024; Iftikhar et al., 2022), analyzing the impact of instructional design of computer networking course toward learning outcome (Chandrasekaran et al., 2021; Walters-Williams, 2023). However, the evaluation of the implementation of practice-based learning course as a whole program in the context of distance education has not been carried out systematically and comprehensively. In this context, an evaluation approach is needed that not only assesses aspects of learning outcomes, but also includes the context of implementation, resource readiness, learning process, to the results and their impacts.

One relevant approach is the CIPPO (Context, Input, Process, Product, Outcome) model, a development of the CIPP evaluation model by Stufflebeam, which is designed to evaluate educational programs holistically and based on decisions (Imansari & Sutadji, 2017; Purnawirawan et al., 2020; Yazdimoghaddam et al., 2021; Yoshany et al., 2025). The CIPPO model allows evaluations to be carried out in a structured manner: starting from evaluating the policy context and learning needs (Iqbal et al., 2021; Kusmiyati et al., 2023; Purnawirawan et al., 2020; Tanjung, 2023; Widayanto et al., 2021), resource readiness (Lahme et al., 2023; Reyes-Millán et al., 2023), the effectiveness of the learning process (Balalle, 2024; Sapriati, et al, 2023; Sung et al., 2021), student assignment performance (Jacko et al., 2022; Motz et al., 2021; Oseredchuk et al., 2022), to the achievement of work skills and student satisfaction. The use of this framework in the context of online practice-based learning based on blended distance learning is relevant to obtain a holistic picture that can be used as a basis for the development and innovation of future learning programs. Based

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on this background, this study aims to evaluate the implementation of Desktop Programming Practice-based learning and Computer Network Practice-based learning in a blended distance learning format in a higher education environment using the CIPPO model.

The results of this evaluation are expected to provide data-based recommendations for strengthening curriculum policies, improving instructional design, increasing tutor capacity, and increasing the achievement of technical competencies and student work readiness. This study aims to conduct a comprehensive evaluation of the implementation of Desktop Programming Practice-based learning and Computer Network Practice-based learning held in a blended distance learning format in a higher education environment, especially in the Information Systems Study Program. The evaluation was conducted using the CIPPO model approach which includes five main dimensions, namely as follows.

1. Context - Identifying the relevance and clarity of institutional policies, practice-based learning guidelines, and the readiness of the learning system
2. Input - Evaluating the readiness of resources such as software, hardware, teaching materials, and tutor competence.
3. Process - Examining the quality of practice-based learning implementation, student-tutor interactions, and the dynamics of online discussions and collaborations.
4. Product - Analyzing student learning outcomes through assessment of assignments, exams, and practice-based learning products.
5. Outcome - Measuring student perceptions of improving technical skills, readiness to face digital work challenges, and satisfaction with the learning process.

The theoretical benefits of this study are to contribute to the development of an outcome-based evaluation model for education, especially in online practice-based learning courses, and to expand the use of the CIPPO model in the context of vocational and professional education based on information technology, which has so far been used more in the fields of training and health. This study aims to provide data-based input to study program managers and higher education institutions regarding the strengths and weaknesses of the implementation of online practice-based learning that are currently being carried out, to become the basis for considering curriculum improvements, especially in terms of updating

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practice-based learning materials, providing supporting devices, and strengthening the role of tutors, and providing strategic policy recommendations to improve graduates' work readiness through a more adaptive, collaborative, and technology-based practice approach. The social and industrial benefits of this study are to support efforts to prepare graduates who are ready to enter the digital job market with technical competencies and soft skills that are in accordance with the needs of industry 4.0, and to help distance learning institutions to increase competitiveness and stakeholder trust through the implementation of quality and measurable practice-based learning.

THEORETICAL FRAMEWORK

1. Theoretical Foundation

Practice-based learning is a crucial part of technology-based higher education including in Information Systems study programs. It not only functions as a means of technical training, but also as a vehicle for developing problem-solving, creativity, and teamwork (Dryjanska et al., 2022; Zinming, 2023). Desktop programming practice-based learning train logic and problem-solving algorithms, while computer network practice-based learning equip students with basic technical skills in building and managing network infrastructure (Deng, 2021; Popoviciu & Li, 2023).).

Online-based practice-based learning has experienced accelerated adoption since the pandemic, but still faces challenges in terms of interactivity, gaps in technology access, and learning effectiveness (Lahme et al., 2023; Reyes-Millán et al., 2023). Therefore, the blended distance learning approach is widely chosen as a compromise between flexibility and effectiveness of practice learning (Gomez-del Rio & Rodriguez, 2022; Lampropoulos & Sidiropoulos, 2024; Pollock, 2022; Sanchez et al., 2022; Tatenov et al., 2023).

The current paradigm of higher education is shifting to the Outcome-Based Education (OBE) model, which emphasizes measurable learning outcomes that are relevant to industry needs (Jackson et al., 2020; Leandro Cruz & Saunders-Smits, 2021). Students are not only expected to understand theory but also to be able to apply knowledge in real contexts (Asim et al., 2021; Sun & Xu, 2024). Outcome-based education (OBE) has become the dominant

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approach in IT curriculum development, including practice courses (Abdiyev et al., 2023; Jiao et al., 2021; Mardis et al., 2018; Oyetade et al., 2025; Wu et al., 2023; Zhang et al., 2021).Future skills such as programming, network systems, computational thinking, online collaboration, and digital ethics are an important part of a curriculum that is adaptive to the industrial era 4.0 (Alowais et al., 2023; Bühler et al., 2022; Barua & Lockee, 2024; Erduran & Levrini, 2024; Ngoasong, 2022; Ouyang et al., 2023;).

2. CIPPO Evaluation Model in Education

The CIPPO (Context, Input, Process, Product, Outcome) model is an extension of the CIPP model developed by Stufflebeam. This model is designed to evaluate educational programs comprehensively from planning to results (Imansari & Sutadji, 2017; Purnawirawan et al., 2020; Yazdimoghaddam et al., 2021; Yoshany et al., 2025). Within the context component, the focus is on assessing the relevance of needs, policies, and learning environments, as highlighted by Iqbal et al. (2021) and Kusmiyati et al. (2023), as well as Purnawirawan et al. (2020), Tanjung (2023), and Widayanto et al. (2021). These studies emphasize that understanding the alignment between educational policies, institutional needs, and the actual learning environment is essential for effective program implementation.

The input stage involves analyzing the readiness of human resources, infrastructure, and content, as discussed by Lahme et al. (2023) and Reyes-Millán et al. (2023). Adequate preparation in these areas ensures that both technical and pedagogical requirements are met before implementation begins. In the process phase, attention is given to observing the dynamics of implementation, the nature of learning interactions, and the constraints encountered. Research by Ateş and Köroğlu (2024), Balalle (2024), Kotsis (2024), Ng et al. (2022), Nungu et al. (2023), Ouyang et al. (2023), Sapriati et al. (2023), and Sung et al. (2021) reveals that successful delivery depends on managing interaction patterns, addressing technical and logistical barriers, and fostering a conducive learning atmosphere.

The product dimension evaluates the achievement of tasks, learner activeness, and the quality of student work products, as evidenced by Jacko et al. (2022), Motz et al. (2021), and Oseredchuk et al. (2022). The outcome component measures the impact on students' work readiness and competency development. Studies by Abdiyev et al. (2023), Jiao et al. (2021),

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Mahasneh and Murad (2022), Mardis et al. (2018), and Oyetade et al. (2025) indicate that well-structured learning programs can significantly enhance professional preparedness and skill acquisition.

Several previous studies have successfully applied CIPPO to evaluate vocational training programs and online learning, demonstrating the flexibility of this model in various educational contexts (Imansari & Sutadji, 2017; Kusmiyati et al. 2023; Purnawirawan et al., 2020; Tanjung, 2023; Widayanto et al. 2021). Belt and Lowenthal (2021), Donkin et al. (2019), Kerman et al. (2024), Meng et al. (2022), Reyes et al. (2024), and Shelby and Fralish (2021) demonstrated that the use of multimedia feedback and peer collaboration enhanced the performance of online lab assignments. Their findings highlight the pedagogical value of integrating diverse feedback modalities and collaborative learning strategies in virtual laboratory environments.

Similarly, Al-Bahadli et al. (2023), Chen et al. (2019), Ospankulova et al. (2024), Umar and Ko (2022), and Zen and Ariani (2022) reported that project-based group work effectively increased students' engagement and deepened their understanding of technical concepts. These results underscore the role of collaborative project-based approaches in fostering active participation and conceptual mastery in technical education. Moreover, studies by Bayoumy and Alsayed (2021), Shao et al. (2024), and Tao et al. (2022) provided evidence that active student involvement was significantly correlated with academic achievement. This suggests that fostering learner agency and active participation can be a key determinant of educational outcomes.

In addition, Jacko et al. (2022), Motz et al. (2021), and Oseredchuk et al. (2022) emphasized the critical importance of task monitoring and early warning systems in online learning platforms. Such mechanisms are instrumental in identifying at-risk learners and enabling timely interventions to support their progress.

Furthemore, Imansari and Sutadji (2017), Kusmiyati et al. (2023), Purnawirawan et al. (2020), Tanjung (2023), and Widayanto et al. (2021) suggested the application of the CIPPO model for competency-based training across the domains of education, industry, and health.

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This model offers a structured framework for evaluating and enhancing training effectiveness in various professional contexts.

Although the CIPPO model has been widely used in education, there are still few studies that apply it comprehensively to the evaluation of online IT-based practice-based learning, especially in the context of blended distance learning and for courses such as desktop programming and computer networks. In addition, the relationship between evaluation results and industry needs has not been studied systematically in Indonesia. The literature review shows that online-based practice-based learning are very important but complex. Furthermore, a comprehensive evaluation with an approach such as CIPPO is needed for continuous improvement. This study fills an important gap in the study of blended practice-based learning evaluation based on future work skills.

RESEARCH METHOD

1. Design of Research

This study uses a descriptive evaluative approach with the CIPPO (Context, Input, Process, Product, Outcome) model as the main framework to evaluate the implementation of Desktop Programming Practice-based learning and Computer Network Practice-based learning held in a blended distance learning scheme. The mixed methods approach is used to gain a deeper understanding of the phenomena studied, by combining quantitative data (questionnaires, LMS statistics) and qualitative (open interviews, online interaction observations).

2. Research Participant and Setting

This study was conducted on third and fifth semester students of the Information Systems Study Program at a college that provides distance learning. There were 2 courses evaluated, namely Desktop Programming Practice-based learning (using Windows-based IDE) and Computer Network Practice-based learning (UTP-RJ45 cable assembly practice and network simulation). The number of respondents who were actively involved was 215 students, as well as 12 tutors who were involved as online learning facilitators. The evaluation setting was carried out through the internal LMS platform, discussion forums, web pages, and synchronous channels such as Zoom and Telegram.

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3. Data Gathering Tools

Data were collected through three types of instruments, questionnaires, observations, and interviews. Closed and open-ended questionnaires based on a Likert scale of 1–5 were used to measure students' perceptions on the five dimensions of CIPPO. Observations of digital activities through LMS platform logs and web-based were conducted for both courses with aspects observed including login frequency, assignment submission, and participation in forums as well as student discussion and assignment scores. Semi-structured interviews with 25 students and 6 tutors were conducted to explore experiences, challenges, and program development proposals. The validity of the instrument content was consulted with learning evaluation experts and educational IT practitioners. The reliability of the questionnaire was tested using the Cronbach's Alpha coefficient which showed a value of 0.89 (very high category).

4. Data Analysis

Quantitative data were analyzed descriptively using statistics using percentages, means, and distributions of scores per CIPPO dimension. Qualitative data were analyzed using data reduction techniques, thematic coding, and triangulation between sources (interviews, observations, documents). CIPPO cross-dimensional analysis was conducted to identify relationships between policy context, technology input, interaction processes, product quality, and their impacts on learning outcomes. This study has obtained approval from the institution and involved voluntary participants. Personal data were encoded to maintain confidentiality, and the results of the analysis were not used for individual assessment.

FINDINGS AND DISCUSSION

1. Context: Institutional Readiness and Practice Policy

The research results showed that at the beginning of the semester there were a number of students who still did not understand the implementation of practical/practicum-based courses. These results indicate that information about the technical implementation of practicums is still not well received by all students, even though this information has been listed in the study program catalogue. Thus, socialization, orientation and dissemination of

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practice-based courses must be carried out properly at the beginning of each semester using various media. In addition, the information must be guaranteed to be properly understood by students.

A similar thing was expressed by Iqbal et al. (2021), Kusmiyati et al. (2023), Purnawirawan et al. (2020), Tanjung (2023), Widayanto et al. (2021), who emphasized the importance of clear policy communication in an online learning environment. García-Holgado and García-Peñalvo (2022), Jayasekara (2024), and Shunkov et al. (2022) suggested that multimedia-based orientation sessions can help bridge the gap between policy and field practice, which is not yet optimal in the context of blended learning.

2. Input: Tutors, Infrastructure, dan Technical Support

The results of interviews and observations showed that the management of the tutorial class authorization administration process has been implemented well. However, tracking data and documents about these activities takes a little longer than expected, so it is necessary to think about more systematic administration and archiving of these activities. Furthermore, the observation results show that semester-based tutor performance evaluation has been carried out in a structured and programmed manner. The evaluation results have been archived online and are well documented. Every semester, the e-learning system provides a Tutor Evaluation Questionnaire which students fill out in the eighth session. This questionnaire is used as justification for study program management to determine whether a tutor can be re-recruited or not in the following semester. Follow-up evaluation results have been carried out for the purposes of recruiting tutors and tutorial activities, but these results have not been used as a basis for policies to comprehensively improve the quality of learning, research and community service.

Every semester, tutors also receive reminder emails from the Study Program/Faculty regarding discussion responses from students and student assignments that have not been assessed by them within the specified deadline. However, the results of the reminder process carried out still did not get optimal results because the reminder process was still focused on certain staff. The activity does not seem to involve all teaching lecturers in a programmatic way to participate in following up on reminders to the tutors. In addition, the implementation

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of this activity is not yet equipped with an integrated application to support the process of remembering grades by the tutors.

Observation results have shown that all practicum-based courses are not equipped with a "hits report" facility, which is an activity log, to make the monitoring process easier for course and study program instructors. This has an influence on the work speed of lecturers who are tasked with managing tutorial class authorization to access tutor activity data in a timely manner. At the time the research was carried out, information was obtained that the study program was developing these facilities which were expected to be used in the following semester. Some students still face difficulties in accessing practical tools and software such as Java Environment. In addition, there are still some tutors who have not been able to consistently provide feedback on each discussion response post on time within the specified deadline, as reflected in interview and questionnaire data.

A study by Lahme et al. (2023) and Reyes-Millán et al. (2023) confirmed that access to devices and tutor activeness are important predictors of online practice-based learning success. Our research supports this by showing a correlation between tutor inactivity and low assignment submission. The addition of virtual simulations (e.g. Online Cisco Packet Tracer for networking, and online IDE platforms for programming) and flipped mentoring-based tutor training would be strategic interventions that are in line with the AI-enhanced practice labs approach as outlined by Alowais, et al (2023). Online Cisco Packet Tracer for networking, and online IDE platforms for programming) and flipped mentoring-based tutor training would be strategic interventions that are in line with the AI-enhanced practice labs approach as outlined by Alowais et al. (2023), Erduran and Levrini (2024), Ouyang et al. (2023).

3. Process: Activity, Interaction, and Dynamics of Collaboration

The findings showed that there were disparities in students' experiences in interacting, both with tutors and between fellow students. Variations were also seen in the feedback obtained, some students received feedback within the expected time, while other students received feedback outside the expected time. Most students stated that they could learn

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better through discussions with fellow students or asking questions or consulting seniors or practitioners who had expertise, either online synchronously or face to face.

Ateş and Köroğlu (2024), Kotsis (2024), Ng et al. (2022), Nungu et al. (2023), and Ouyang et al. (2023) showed that structured peer collaboration improves students' understanding of online practice-based learning. Meanwhile, Belt and Lowenthal (2021), Donkin et al. (2019), Kerman et al. (2024), Meng et al. (2022), Reyes et al. (2024), and Shelby and Fralish (2021) emphasized that multimedia feedback and peer review can build emotional involvement in practice learning. Recommendation: Implement a Discord or Telegram-based learning community model that is structured based on practice-based learning themes, and not just general topics per week. Students will discuss a conceptual and best practice in real world problem as a group in channel group. It is also suggested that program study could provide additional training workshop for using practicum kits.

4. Product: Students' Task Achievement

Based on Table 1 and Table 2, students showed better achievement in the network laboratory practicum than in the desktop programming practicum. However, the findings showed that there were still problems in completing the submission of assignments, The findings indicated that students have not submitted completely 3 assignments, respectively around 25% for the Desktop Programming practicum and 30% for the Computer Network practicum This problem seemed caused by a lack of understanding regarding task completion and task deadlines.

Table 1. Completeness of Assignments Collected from Students Who Submit Assignments

Subject Name	**Number and percentage of completeness of collected assignments**			**Total**
	1	2	3	
Desktop Programming	65 (9.13%)	120 (16.85%)	527 (74.02%)	712
Computer Network	90	101	453	644

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(13.98%)	(15.68%)	(70.34%)	

Table 2. Students' assignments average score in practice-based courses

Subject Name	Assignment Average Score			
	1	**2**	**3**	Students who completed all assignments (1,2,3)
Desktop Programming	80	82	82	81
Computer Network	87	85	85	88

A study by Jacko et al. (2022), Motz et al. (2021), and Oseredchuk et al. (2022) proved that the integration of notification systems and deadline reminders increased assignment completeness. Jacko et al. (2022) indicated that the integration of notification systems and deadline reminders increased assignment completeness. The addition of a progress dashboard and analytics-based motivational nudges will strengthen the product dimension of CIPPO model.

5. Outcome: Impact of Practice-based learning on Industrial Readiness

Students who take these two practicum courses already have jobs in the field of Information Technology or in the administrative field that uses computers. Interviews showed that students considering the practicum had a good contribution to their attitudes, interests, course achievements and current work. However, they stated that the content for desktop programming needs to be reviewed, thus the content better meets the needs of the current industry, which is more focused on mobile and cloud computing. The students considered that they have additional experience to apply to their work and have better problem-solving skills. Such as, after taking the practicum, they have a better understanding of computer networks and programming and can help with simple troubleshooting.

In addition, findings showed that students feel more confident in solving technical problems in the workplace after participating in network practice-based learning, even though their

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previous education or experience is not directly related to the field of Information Technology. Furthermore, in general, students perceived that there was relevance between learning outcomes and practical assignments and their work needs. However, to gain a better understanding and ability to meet future needs, they hope that there will be training, simulations, bootcamp activities, webinars, certification programs, beyond those provided in courses and practicums.

This finding is reinforced by Abdiyev et al. (2023), Jiao et al. (2021), Mardis et al. (2018), and Oyetade et al. (2025) who emphasized the importance of an industry-aligned curriculum. Babalola and Fakoyede (2022), Hammersley et al. (2025), Henríquez and Hilliger (2024), Joshi et al. (2020), and Ferreira et al. (2024) recommended the inclusion of industry immersion modules in online practice-based learning to bridge the expectations of the working world.

CONCLUSIONS

This study showed that the application of practice-based learning for Desktop Programming and Computer Networks in a blended distance learning scheme has great potential to build students' future skills. However, the study courses still face real challenges in aspects of learning design, tutor involvement, and infrastructure readiness. The CIPPO evaluation model approach has proven effective in providing a comprehensive picture of the implementation of online practice-based learning, starting from aspects of institutional policy to its impact on student work readiness.

The evaluation of the context dimension showed the importance of clear and structured policy communication. In terms of input, device readiness and facilitator quality are crucial. In the process, interactive and collaborative learning has a significant impact on engagement. Meanwhile, the product and outcome dimensions showed that students who are active and well-facilitated tend to show better performance and feel more prepared to face the world of work. This study confirms that to produce technically competent and industry-relevant graduates, information technology-based practice-based learning need to be organized adaptively, inclusively, and integrated with the needs of the digital era.

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The practice implications of the study can be shown from several aspects as explained below. From the aspect of simulation-based practice-based learning design and industry reality, higher education institutions need to develop adaptive practice-based learning formats that combine virtual simulations, industry-based projects, and tutor guidance. Programming practice-based learning should start to include the context of mobile application development, cloud, and lightweight AI. Network practice-based learning should simulate real scenarios such as troubleshooting smart home or IoT systems. For the aspect of tutor training as a facilitator where the tutor is not just a material deliverer, but an online learning facilitator.

E-moderation competency training and proactive digital communication are needed to support interactive learning dynamics. Approaches such as live diagnostics, screen sharing mentoring, and data-based formative feedback need to become new standards. For the aspect of strengthening the collaborative learning ecosystem, the implementation of a peer mentoring system, problem-based discussions, and collaborative project-based learning must be the main architecture in implementing practice-based learning. Platforms such as Discord, Notion, or GitHub Classroom can be utilized to support communication and progress tracking. For the integration of learning analytics and adaptive interventions, institutions are advised to implement an engagement dashboard and smart notifications based on learning analytics to detect decreased motivation, late assignments, and special guidance needs. Adaptive intervention models can be developed based on this data.

Furthermore, for the aspect of synchronization with the world of work, the practice-based learning curriculum must be aligned with the industry certification framework (such as Cisco, Microsoft, or CompTIA) and involve practitioners as co-supervisors in the final practice-based learning project. This expands the function of the practice-based learning from a learning space to a simulation of the work ecosystem. Online practice-based learning are not just adaptations of face-to-face learning, however rather a space for pedagogical innovation that requires transformation of strategy, roles, and technology. With a comprehensive evaluation such as through the CIPPO model, higher education institutions

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can re-arrange practice-based learning teaching strategies that not only educate but also empower students to grow as future digital talents.

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