

Bridging Skill Gaps with AI: Implementation and Evaluation of Proficiency+ in the Malaysian Civil Service

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Abstract

The rapid evolution of digital competencies within public sector organizations necessitates personalized and data-driven professional development strategies. This study investigates the Proficiency+ AI-driven course recommendation and skill gap analysis system, developed by the National Institute of Public Administration (INTAN), to enhance learning personalization, identify skill gaps, and optimize resource allocation among Malaysian civil servants. Drawing on the literature on adaptive learning platforms, AI-powered recommender systems, and skill gap diagnostics, the study situates Proficiency+ within contemporary workforce development and educational technology frameworks. Employing a convergent mixed methods research design, data were collected through system logs, structured surveys, and semi-structured interviews across a stratified sample of 150 public officers. Quantitative analyses included descriptive statistics, correlation, and multiple regression to examine relationships between skill gaps, course recommendation acceptance, and engagement, while thematic analysis interpreted qualitative responses. Findings reveal that Proficiency+ effectively aligns training recommendations with individual competency gaps, particularly in AI and data literacy, achieving a high recommendation acceptance rate (78.4%) and robust engagement. Skill gaps were significant predictors of system utilization, indicating the platform's precision in targeting high-need areas. The system's visualizations and dashboards also facilitated resource optimization for INTAN, supporting SDG 4 (Quality Education) by promoting equitable, relevant learning opportunities, and SDG 8 (Decent Work and Economic Growth) by fostering workforce readiness. In conclusion, Proficiency+ demonstrates that AI-driven learning systems can enhance personalization, skill development, and institutional efficiency in public sector training. Recommendations include expanding competencies covered, integrating adaptive feedback mechanisms, and continuous monitoring to maintain alignment with evolving organizational needs....

Keywords: Proficiency+, AI-driven learning, Skill gap analysis, Course recommendation system, Public sector workforce development.

INTRODUCTION

In an era defined by rapid technological transformation and increasingly dynamic work environments, public sector institutions face a mounting imperative to equip their workforce with relevant competencies that match evolving organizational needs. Artificial Intelligence (AI) and data-driven systems have reshaped numerous domains including education, skill development, and professional learning by enabling adaptive, personalized learning experiences that align resources with individual learner profiles and evolving labor market demands. The application of AI in educational and training contexts has expanded significantly, with research demonstrating how recommender systems can tailor learning pathways based on user data, thereby enhancing engagement and learning outcomes (Najafabadi et al., 2026). Adaptive learning technologies, which leverage algorithms to respond to learner strengths and weaknesses, have shown promise in optimizing instruction and improving knowledge retention across a variety of settings.

Within public administration contexts, the traditional model of training has historically relied on uniform curricula that often fail to address the diverse skill profiles of officers across different agencies and functional areas. Moreover, the accelerating demand for digital competencies, particularly in AI, machine learning, and data literacy, has intensified the urgency for systems that can not only recommend relevant courses but also systematically identify and fill skill gaps (Saukkonen et al., 2025). In Malaysia, the public sector's strategic vision for digital transformation underscores the integral role of continuous learning and professional development in enhancing governance capacity and service delivery (Firdaus et al., 2024). These broader policy directions reflect a global trend where governments and organizations are recalibrating training paradigms to meet the needs of an increasingly complex skills landscape.

Despite recognition of the importance of personalized learning pathways, existing professional development frameworks within the public sector remain largely fragmented, with limited integration of advanced analytics or machine learning capabilities. Such systems often lack the computational sophistication to parse complex training and competency data, generate precise recommendations, or effectively map an officer's current capabilities against future role requirements. Furthermore, in practice, the absence of systematic skill gap diagnostics and targeted course alignment contributes to inefficiencies, including underutilized training resources, redundancy in course offerings, and a persistent mismatch between training provision and organizational competency needs. These limitations are compounded by challenges typical of AI recommender systems, such as data sparsity, cold-start issues with new users, and scalability concerns, which impede the delivery of accurate and contextually relevant recommendations.

Accordingly, there is a clear need for an AI-driven solution capable of addressing these systemic challenges by combining robust analytical methods with an intuitive interface for both learners and administrators. The Proficiency+ system, developed by the National Institute of Public Administration (INTAN), proposes such a solution by incorporating hybrid recommendation techniques, competency frameworks, and interactive visualizations to personalize learning and support strategic training decisions. However, while the theoretical advantages of AI-enhanced learning systems are well documented, empirical evidence on their effectiveness within public sector training particularly in relation to skill gap identification, personalized course recommendation, and impact on workforce readiness remains limited. This research therefore seeks to investigate the development and implementation of Proficiency+ in order to evaluate how such systems can address entrenched training inefficiencies and foster a future-ready public administration workforce. The purpose of this study is to examine the capability of the Proficiency+ system to improve personalized learning, identify skill gaps, recommend targeted training, and enhance overall training effectiveness within Malaysia's public sector workforce..

Literature Review

Artificial Intelligence (AI) and machine learning have been increasingly incorporated into educational environments to support personalized learning, adaptive instruction, and predictive analytics. A large body of research on AI-enabled adaptive learning platforms highlights how such systems use learner data to dynamically adjust instructional content, pacing, and pathways according to individual needs and performance outcomes (Tan et al., 2025). These studies collectively suggest that adaptive systems can significantly enhance engagement and learning outcomes by aligning content delivery with learner proficiency and preferences, thereby minimizing cognitive overload and promoting efficient instruction.

Within this domain, recommendation systems form a critical sub-category of AI learning technologies. Recommender systems are defined as information-filtering tools that predict user preferences and suggest items like courses or content based on historical behavior and similarity metrics a principle widely used in commercial platforms and increasingly explored in education (Wikipedia contributors, 2024). Research indicates that hybrid recommendation approaches, combining collaborative and content-based filtering, outperform singular methods by addressing limitations such as cold-start and sparsity problems while improving recommendation accuracy.

Several empirical studies have examined the integration of AI in personalized learning and skill recommendation. Systematic reviews of adaptive and personalized learning research show that AI algorithms such as decision trees, neural networks, and clustering methods are frequently applied in educational recommendation systems to tailor learning pathways and improve learner outcomes. These studies also highlight persistent challenges including

infrastructure constraints, ethical and privacy concerns, and uneven adoption across contexts. Moreover, research on *AI-based adaptive tutoring frameworks* like ALIGNAgent demonstrates how skill gap identification and targeted content retrieval can be effectively integrated, yielding high precision and balanced recommendation performance in academic settings.

Despite this progress, research exploring skill gap analysis as a component of AI-driven professional learning systems remains more limited, particularly within public sector training. Literature tends to focus on traditional educational environments (e.g., higher education and vocational training), where adaptive recommendation and career prediction systems are investigated. One systematic review identified a gap in unified AI-driven frameworks that consistently diagnose competencies and suggest pathways tailored to individual learner characteristics, emphasizing the need for more integrated models that combine job role requirements, learner profiles, and industry needs.

The theoretical foundations that support AI-driven course recommendation and skill analysis systems draw from multiple disciplines. Adaptive learning theory posits that learning environments should respond to individual differences in knowledge, cognitive load, and learning preferences, tailoring instruction accordingly to maximize learning potential. Additionally, educational recommender systems research underscores the importance of *user modeling* building representations of learners' goals, abilities, and preferences to improve recommendation relevance. This aligns conceptually with personalized learning frameworks that aim to scaffold learners toward competency mastery by leveraging real-time data and predictive analytics.

Conceptually, AI-driven professional development systems integrate these elements through a pipeline that combines learner profiling, competency gap diagnosis, and adaptive recommendation generation. Such systems align with broader educational frameworks like Universal Design for Learning (UDL), which advocates for flexible learning pathways that accommodate individual differences and promote equity in learning opportunities.

Collectively, the literature underscores the value and complexity of AI-enabled learning systems, while also highlighting the need for context-specific research that evaluates their effectiveness in real-world professional development settings.

Research Methodology

This section explains the research design, procedures, sampling, data collection, and data analysis techniques adopted in the study of the *Proficiency+ AI-Driven Course Recommendation and Skill Gap Analysis System*. Given the multifaceted nature of training personalization and competency diagnostics in public administration, a mixed methods research design was used to harness the strengths of both quantitative and qualitative approaches. Mixed methods designs enable researchers to integrate numerical measurement with contextual insight, thereby yielding a more holistic understanding of complex phenomena (Creswell & Creswell, 2022). Such a methodology is particularly appropriate when examining technological systems like AI recommender engines, where user perceptions, system accuracy, and measurable outcomes must be interpreted in conjunction (Kharuddin & Ismail, 2017).

Research Design

A convergent parallel mixed methods design was implemented, in which quantitative and qualitative data were collected and analyzed concurrently but independently, before being integrated at the interpretation stage. This approach balances the statistical robustness of quantitative findings with the depth of qualitative exploration (Creswell & Creswell, 2022). Quantitative components focused on statistical relationships between system outputs (e.g., recommended courses, detected skill gaps) and user characteristics, while qualitative components provided explanatory insights into officer experiences, perceptions of relevance, and contextual barriers to adoption. The convergent design supports triangulation by corroborating evidence from different data streams to enhance validity and interpretative rigor.

Sampling and Population

A stratified random sampling strategy was employed to ensure representativeness across different civil service agencies and job categories. Stratification was based on professional clusters such as administrative officers, IT

specialists, and managerial personnel. Stratified sampling is advantageous in studies requiring subgroup representation because it reduces sampling bias and enhances the precision of estimated effects (Adeoye, 2023). Within each stratum, simple random sampling was applied to select participants, thereby providing equal chances of selection and facilitating generalizability to the broader officer population.

$$\text{Sample size} = \frac{N}{1 + (N \times e^2)}$$

where N is the population size and e is the margin of error (0.05), a formula commonly used for determining representative sample sizes in survey research.

Data Collection Procedures

Data collection involved a combination of structured surveys, system-generated logs, and semi-structured interviews. The survey instrument measured variables such as perceived relevance of recommendations, self-reported skill competencies, and satisfaction with the recommendation system. System logs from Proficiency+ documented interaction data, course selections, and inferred skill gaps, providing objective performance measures. Semi-structured interviews with a subset of participants elicited contextual narratives on how officers interpreted and acted upon system suggestions.

Surveys and logs provided quantifiable data suitable for statistical analysis, while interviews offered qualitative data for thematic analysis. Prior to data collection, the survey instrument was pilot-tested for reliability and clarity, and ethical approval was obtained in accordance with institutional standards.

Data Analysis

Quantitative data were analyzed using descriptive and inferential statistics. Descriptive statistics (means, standard deviations) summarized central tendencies of key variables, while inferential techniques, such as correlation analysis and multiple regression, assessed relationships among skill levels, recommendation acceptance, and training outcomes. Statistical software packages (e.g., SPSS, R) facilitated computation and hypothesis testing at a 95% confidence level.

For qualitative data, thematic analysis was conducted to identify recurring patterns and interpretative themes in interview transcripts. This process involved initial coding, theme development, and iterative refinement of codes to ensure conceptual coherence (Braun & Clarke, 2022). Computer-assisted qualitative data analysis software (CAQDAS) supported transcript management, coding consistency, and theme visualization.

Finally, quantitative and qualitative results were integrated in a meta-inference phase, where narrative findings complemented statistical trends to construct a comprehensive interpretation of how Proficiency+ influenced personalized professional learning and skill gap recognition. This mixed methods approach strengthens both the explanatory and predictive power of the research conclusions.

Data Analysis, Results, and Findings

The data collected from the Proficiency+ system were subjected to a combination of descriptive and inferential statistical analyses to examine skill profiles, course recommendation acceptance, and training effectiveness. Descriptive statistics were computed to summarize the central tendencies and variability of participants' skill levels and engagement with the system. Inferential analyses, including Pearson correlation and multiple regression, were employed to assess the relationships between identified skill gaps, recommendation utilization, and perceived learning outcomes.

Skill gaps were quantified by comparing participants' self-reported competencies against predefined role-based competency benchmarks. Course recommendation effectiveness was evaluated by examining the alignment between suggested courses and participants' identified skill gaps, as well as subsequent participation rates. Data visualization techniques, including bar charts and radar plots, were used to present a clear depiction of skill strengths, development areas, and recommendation uptake. All analyses were performed using Python (pandas, scikit-learn) and R statistical software, ensuring reproducibility and robustness.

A total of 150 public sector officers participated in the study, representing multiple functional groups within INTAN. Table 1 summarizes descriptive statistics for participants' skill competency scores, course recommendation acceptance, and engagement levels.

Table 1: Descriptive Statistics of Participants' Skills and Engagement

Variable	Mean	SD	Min	Max
Technical Skill Competency (1-5)	3.42	0.68	2.0	5.0
Administrative Skill Competency	3.76	0.59	2.5	5.0
AI & Data Literacy Competency	2.91	0.72	1.0	4.5
Course Recommendation Acceptance (%)	78.4	12.3	50	100
Engagement with System (1-5)	4.12	0.58	3.0	5.0

The data show that administrative skills were relatively stronger among participants, whereas AI and data literacy skills were comparatively lower, highlighting a potential area for targeted training. Notably, the overall course recommendation acceptance rate was high (78.4%), indicating that the system successfully matched participants' skill gaps with relevant training offerings. Engagement levels with the system were also high, suggesting usability and perceived relevance of recommendations.

Table 2 presents the results of a correlation analysis exploring relationships between skill gaps, recommendation acceptance, and engagement.

Table 2: Pearson Correlation Coefficients Among Key Variables

Variables	Technical Skill Gap	Administrative Skill Gap	AI & Data Skill Gap	Recommendation Acceptance	Engagement
Technical Skill Gap	1.00	0.35*	0.28*	-0.41**	-0.38**
Admin Skill Gap	0.35*	1.00	0.22	-0.29*	-0.25*
AI & Data Skill Gap	0.28*	0.22	1.00	-0.47**	-0.42**
Recommendation Acceptance	-0.41**	-0.29*	-0.47**	1.00	0.52**
Engagement	-0.38**	-0.25*	-0.42**	0.52**	1.00

Note. $p < .05$, $p < .01$

The negative correlations between skill gaps and recommendation acceptance indicate that participants with larger skill deficiencies were more likely to engage with suggested courses, suggesting that Proficiency+ effectively targeted areas of high need. Additionally, positive correlations between recommendation acceptance and engagement indicate that officers who acted upon the system's suggestions also tended to interact more actively with the platform, reflecting higher motivation and perceived value.

Table 3 summarizes the results of a multiple regression analysis examining the predictive effect of skill gaps on recommendation acceptance.

Table 3: Multiple Regression Analysis Predicting Recommendation Acceptance

Predictor Variable	B	SE B	β	t	p
Technical Skill Gap	-0.38	0.09	-0.34	-4.22	.001**
Administrative Skill Gap	-0.21	0.08	-0.19	-2.63	.010*
AI/Data Skill Gap	-0.45	0.10	-0.41	-4.50	.001**
Constant	85.3	2.15	—	39.77	.001

$$R^2 = 0.42, F(3, 146) = 35.3, p < .001, \text{Note. } p < .05, p < .01$$

The regression analysis indicates that all three skill gaps significantly predicted recommendation acceptance, with AI and data literacy gaps showing the strongest effect ($\beta = -0.41$, $p < .01$). These findings demonstrate that Proficiency+ prioritizes high-impact training for participants with the most significant skill deficiencies. The model explains 42% of the variance in recommendation acceptance, indicating substantial explanatory power.

The results provide clear evidence that the Proficiency+ system successfully identifies and addresses skill gaps among public sector officers. Descriptive statistics highlighted specific areas of competency deficiency, particularly in AI and data literacy, which underscores the need for targeted interventions in digital skill development. The high recommendation acceptance rate and engagement levels suggest that officers perceive the system as relevant, practical, and supportive of their professional development needs.

Correlation analyses further indicate that participants with larger skill gaps are more responsive to system recommendations, reflecting the precision and appropriateness of the AI-driven matching algorithm. Positive associations between recommendation acceptance and engagement also suggest that active participation with the platform reinforces learning motivation and interaction, consistent with research on personalized learning environments (Tan et al., 2025).

Multiple regression results strengthen this conclusion by demonstrating that AI and data literacy gaps are particularly influential in driving course acceptance, highlighting the system's capacity to prioritize critical areas for workforce upskilling. The 42% explained variance suggests that while skill gaps are key drivers of engagement, other factors such as prior experience, motivation, and organizational culture may also influence participation, warranting further study.

Overall, the findings confirm that Proficiency+ effectively integrates skill gap diagnostics with personalized recommendations, improving both learning relevance and engagement. By aligning training opportunities with individual needs, the system enhances professional development efficiency and supports strategic workforce planning within the public sector.

Discussion and Recommendations

The findings of this study demonstrate that the Proficiency+ AI-driven course recommendation and skill gap analysis system effectively achieves its primary objectives of personalizing training, identifying skill gaps, optimizing resource allocation, and supporting continuous professional development among public sector officers. First, in alignment with the objective of developing an intelligent recommendation system, the results showed high acceptance rates (78.4%) and engagement with system-recommended courses, particularly among officers with pronounced skill deficiencies in AI and data literacy. This indicates that AI-enabled matching of course offerings with individual skill profiles enhances learning relevance and motivates participation, consistent with prior research demonstrating that adaptive learning systems improve learner engagement by tailoring content to competency levels (Tan et al., 2025; Najafabadi et al., 2026).

Second, the system successfully identified skill gaps across technical, administrative, and AI/data literacy domains. Regression analysis revealed that AI and data literacy deficiencies were the strongest predictors of course acceptance, emphasizing the importance of addressing digital competencies to future-proof the public sector workforce. This finding aligns with the literature on workforce digital readiness, which emphasizes that targeted interventions are most effective when directed at areas of highest skill deficiency (Saukkonen et al., 2025; Firdaus et al., 2024). Through automated skill mapping, Proficiency+ provides actionable insights that inform both individual learning paths and institutional training priorities, thereby supporting strategic human resource development.

Third, the visualizations and dashboards generated by the system demonstrated the objective of optimizing resource allocation and institutional efficiency. Officers and administrators were able to identify priority training areas at a glance, reducing redundancy in training offerings and facilitating more targeted allocation of institutional resources. This supports the Sustainable Development Goal (SDG) 4; Quality Education by fostering equitable access to training opportunities that are relevant and responsive to individual needs, and SDG 8; Decent Work and Economic Growth by enhancing workforce capacity through targeted upskilling initiatives (United Nations, 2023).

In synthesizing these outcomes, it is evident that Proficiency+ embodies principles of precision learning, where interventions are data-driven, targeted, and continuous. The positive correlations between engagement and recommendation acceptance further suggest that personalized AI recommendations not only improve skill acquisition but also reinforce motivation for ongoing professional development. This resonates with adaptive learning theory, which posits that instruction tailored to individual differences promotes knowledge retention and self-efficacy (Braun & Clarke, 2022).

In conclusion, the study confirms that AI-driven systems like Proficiency+ can significantly enhance public sector training by aligning course offerings with individual skill gaps, promoting engagement, and improving institutional decision-making. The system's ability to identify high-priority skills, particularly in AI and data literacy, provides evidence that technology-enabled learning can bridge competency gaps critical to future workforce readiness. These findings are consistent with previous literature on AI in education and workforce development, which highlights the value of hybrid recommendation models and skill diagnostics in optimizing learning outcomes (Tan et al., 2025; Najafabadi et al., 2026).

Based on the findings, several recommendations are proposed. First, INTAN and similar institutions should continue to expand AI-driven learning platforms to encompass additional competencies, particularly emerging digital skills relevant to the evolving public sector. Second, integrating natural language processing (NLP) and adaptive feedback mechanisms could enhance recommendation precision and real-time personalization. Third, continuous monitoring of skill trends and system utilization is recommended to maintain alignment with organizational and national competency frameworks. Finally, the adoption of AI-enabled systems should be accompanied by robust data governance and fairness audits to ensure ethical and equitable outcomes across all learner groups...

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