

CAPACITY-BUILDING WORKSHOP ON AI LITERACY AND ADAPTIVE LEADERSHIP FOR PRE-SERVICE TEACHERS

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ABSTRACT

Artificial intelligence (AI) and data-intensive school management are widening the competencies expected of future teachers and school leaders. A needs assessment among pre-service teachers at Universiti Tun Hussein Onn Malaysia (UTHM) showed limited understanding of adaptive leadership, ethical AI use, and data-informed decision making. This community service program aimed to strengthen five competency areas: adaptive leadership, AI literacy in education, data-driven decision making, collaborative and innovative culture, and future school leadership perspective. A one-day participatory workshop, held on 22 June 2026 within the ELEVATE 2026 program, combined seminars, case studies, reflective learning, and group discussion. The 45 participants assigned to the team completed an expert-reviewed, 20-item true/false test before and after the workshop. Mean scores rose from 60.6% to 87.8%, a descriptive increase of 27.2 percentage points (average normalized gain 0.69), with the largest absolute increase in AI literacy. Because only aggregated scores were available and no comparison group was used, the change was not tested statistically and is not interpreted as a causal effect. Participants valued hands-on experience of using AI for learning. The program produced reusable materials and was followed by a letter of agreement between the Faculty of Economics and Business, Universitas Negeri Jakarta, and UTHM.

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INTRODUCTION

The digital transformation of education has redrawn the competency map for school leaders. As artificial intelligence (AI), learning analytics, digital platforms, and data-informed management diffuse through schools and universities, they bring opportunity and pressure in equal measure. Leaders now work amid rapid technological change, persistent uncertainty, and shifting stakeholder expectations, conditions under which the conventional administrative repertoire no longer suffices (Taskan et al., 2022; Zawacki-Richter et al., 2019).

Meeting these conditions calls for adaptive capability: the capacity to read environmental change, spur innovation, and hold organizational performance steady while the ground shifts. Rather than reaching for technical fixes, adaptive leaders mobilize people to confront hard problems, share responsibility, and build cultures oriented toward learning (Heifetz et al., 2009). Coupled with distributed and collaborative practice, this stance lets schools respond to disruption coherently without sacrificing educational quality (Spillane, 2005).

The arrival of AI in teaching, learning, and administration has raised the bar further, adding digital literacy and ethical judgment to the leader's brief. The very tools that personalize learning, surface analytics, automate assessment, and support administrative decisions also raise questions of privacy, fairness, transparency, and accountability that leaders cannot hand off to technologists (Fu & Weng, 2024; Holmes et al., 2019; UNESCO, 2021). Knowing how to deploy AI-based tools responsibly has thus become a professional competency in its own right rather than an optional extra (Celik, 2023).

Future leaders must likewise turn evidence into action. As schools accumulate data on student performance, teaching quality, and institutional outcomes, the ability to interpret information, discern meaningful patterns, and translate analysis into strategy has moved to the center of leadership practice (Mandinach & Gummer, 2016; O'Connor & Park, 2023). A recurring finding across systematic reviews, however, is that those closest to education, serving leaders and, above all, pre-service teachers, remain underprepared for AI-rich environments (Bond et al., 2024; Ouyang et al., 2022). This preparation gap is the problem the present program sets out to address.

The program was hosted by Johor Business School (JBS) at UTHM as part of ELEVATE 2026, an international academic program held under the theme "Memperkasa Bakal Guru Mendepani Cabaran Era Digital" (empowering future teachers to meet the challenges of the digital era). Its participants were pre-service teachers enrolled in teacher education

programs at UTHM. A preliminary needs assessment conducted with the host institution surfaced a familiar pattern: participants were comfortable with basic digital tools and general notions of leadership, yet their grasp of adaptive leadership, AI integration, ethical technology use, and data-informed decision making was thin. That profile echoes wider evidence that pre-service teachers' digital competence is uneven, faltering most where pedagogical integration and problem solving are required (Hidayat et al., 2023; Zhang et al., 2025).

In response, the Doctoral Program in Management Science at Universitas Negeri Jakarta (UNJ) delivered an international community service program, *Educational Leadership and School Management: Building Effective Educational Leadership for Future Schools*, that treats adaptive leadership, AI literacy, data use, and collaborative leadership as one integrated competency set rather than a list of separate skills. What distinguishes the initiative is this deliberate coupling of leadership development with ethical AI literacy inside a cross-border, capacity-building format. The program aimed to strengthen participants' understanding in five competency areas: adaptive leadership, AI literacy in education, data-driven decision making, collaborative and innovative culture, and future school leadership perspective. Accordingly, this article documents how the program was implemented, describes the changes in participants' understanding observed between a pre-test and a post-test, presents qualitative observations from the workshop, and reports the program's outputs and follow-up prospects for the collaboration between UNJ and UTHM.

LITERATURE REVIEW

Adaptive and Distributed Leadership in Education

Adaptive leadership denotes the capacity to act effectively amid complexity and uncertainty by separating technical problems, which yield to existing expertise, from adaptive challenges, which demand shifts in values, beliefs, and behavior (Heifetz et al., 2009). In schools, leaders who work adaptively guide change, absorb uncertainty, and keep organizational learning alive, positioning their institutions to meet technological disruption and moving stakeholder demands. The VUCA construct (volatility, uncertainty, complexity, and ambiguity) explains why no single playbook fits every situation and why leaders must match their response to the condition at hand (Taskan et al., 2022). Distributed leadership extends this logic by treating leadership as a practice spread across people and settings, broadening the pool of expertise a school can mobilize when it matters most (Spillane, 2005). In the program, these two ideas were translated into two of the five competency areas. Adaptive leadership was addressed through case studies of school situations shaped by technological disruption, while

distributed leadership informed the collaborative and innovative culture area, which was developed through group discussion.

Digital Literacy and Digital Leadership

Digital literacy comprises the knowledge, skills, and dispositions required to use digital technologies effectively and responsibly at work and in education. For leaders specifically, it means appraising digital resources, encouraging responsible use, and steering institution-wide digital transformation. Reviews of teacher preparation repeatedly find that pre-service digital competence is uneven, even as frameworks such as Technological Pedagogical Content Knowledge (TPACK) continue to organize the knowledge that meaningful technology integration demands (Mishra & Koehler, 2006; Zhang et al., 2025). Principals' digital leadership, that is, their willingness to model technology use and to nurture a digital learning culture, has meanwhile emerged as a precondition rather than a by-product of successful transformation (Karakose et al., 2021).

These related constructs played different roles in the program. Digital literacy served as the overarching orientation of the workshop rather than as a separately measured domain, and it was operationalized through two assessed areas, AI literacy in education and data-driven decision making. Digital leadership informed the future school leadership perspective area, which asked participants to consider how school leaders model technology use, attend to teacher well-being, and cultivate a digital learning culture (Karakose et al., 2021). TPACK and digital transformation were treated as contextual frameworks that explain why these competencies matter for future teachers; neither was assessed directly.

Artificial Intelligence in Education and Its Ethics

Artificial intelligence has become a transformative force in education, enhancing personalized learning, learning analytics, automated assessment, and administrative support (Ouyang et al., 2022; Zawacki-Richter et al., 2019). Systematic reviews warn, however, that the field still leans heavily toward technical concerns while underweighting ethics, context, and the educator's role (Bond et al., 2024); critical scholarship goes further, cautioning against techno-solutionist adoption that discounts the enduring work of teachers (Selwyn, 2019). Responsible practice therefore foregrounds transparency, accountability, fairness, privacy, and human-centered decisions (Fu & Weng, 2024; UNESCO, 2021), and it asks teachers and leaders to build the specific knowledge needed to appraise and integrate AI-based tools ethically (Celik, 2023; Karaduman, 2025). AI literacy itself has been mapped onto four interlocking aspects (knowing and understanding, using and applying, evaluating and creating,

and using AI ethically), giving educators a scaffold for teaching and assessment (Ng et al., 2021). In this program, the four aspects were used to structure the content of the AI literacy session, and the assessment items for this area were written from that session content.

Data-Driven Decision Making

Data-driven decision making is the disciplined use of data and evidence to inform organizational choices and strategy. School leaders draw on data to lift instructional quality, track student outcomes, judge interventions, and allocate resources. Its effectiveness rests on data literacy that is cultivated deliberately during preparation and then reinforced through collaborative structures, professional learning communities chief among them, in which practitioners interpret evidence together and revise their practice accordingly (Mandinach & Gummer, 2016; O'Connor & Park, 2023). In the workshop, this idea was addressed through case studies and group discussion on the use of data in school decisions.

Linking the Concepts to Program Content

Table 1 summarizes how each conceptual basis was translated into a competency area, the corresponding workshop content, and the assessment items. The mapping makes explicit that the five areas, rather than the broader constructs reviewed above, constitute the competency domains targeted and measured by the program.

Table 1. Mapping of conceptual bases to competency areas, workshop content, and assessment items

Conceptual basis	Competency area assessed	Workshop content and activities	Items
Adaptive leadership (Heifetz et al., 2009); VUCA (Taskan et al., 2022)	Adaptive leadership	Lecture on VUCA and adaptive challenges; case studies of technological disruption in schools	4 items
AI literacy, four aspects (Ng et al., 2021); ethics of AI in education (Fu & Weng, 2024; UNESCO, 2021)	AI literacy in education	Session structured around the four AI literacy aspects; case studies on ethics, student data security, and teacher involvement in technology-based decisions	4 items
Data literacy (Mandinach & Gummer, 2016; O'Connor & Park, 2023)	Data-driven decision making	Session on evidence-based school decisions; case studies and group discussion on data use	4 items
Distributed leadership (Spillane, 2005)	Collaborative and innovative culture	Group discussion on collaborative problem-solving and agile school management	4 items
Digital leadership (Karakose et al., 2021)	Future school leadership perspective	Reflection on the school leader's role, teacher well-being, and digital learning culture	4 items

Source: Program design documents, 2026.

MATERIAL AND METHOD

The program adopted a participatory, capacity-building design aimed at strengthening educational leadership competencies among pre-service teachers. It took place on 22 June 2026 at the Tunku Tun Aminah Library, UTHM, in Johor, Malaysia, as part of the ELEVATE 2026 international academic program, and was organized jointly with Johor Business School and the Doctoral Program in Management Science at Universitas Negeri Jakarta. Community service formats of this kind have proved effective for strengthening digital literacy in Indonesian settings (Kurniasih, 2023).

The implementation process consisted of six stages:

1. Identification of participant needs and competency gaps through a preliminary assessment;
2. Coordination and joint program planning with the institutional partner;
3. Development of workshop materials, case studies, and the assessment instrument;
4. Implementation of the leadership and digital literacy workshop;
5. Interactive discussion, case study, and reflective learning activities; and
6. Program evaluation and collection of participant feedback.

The curriculum addressed adaptive leadership, strategic sensemaking under VUCA conditions, ethical leadership, distributed leadership, artificial intelligence in education, agile school management, and data-driven decision making. Each theme was tied to concrete school scenarios so that participants could move readily between concept and practice (see Table 1).

Participants

The ELEVATE 2026 workshop involved 120 pre-service teachers enrolled in teacher education programs at UTHM, who were divided among several facilitation groups. This article reports on the 45 participants assigned to and reached by the authors' group (Group 1: Educational Leadership and School Management); the remaining participants were facilitated by other groups using their own programs. All 45 participants completed both the pre-test and the post-test, and the analysis is based on these complete cases. Participation was voluntary, and the tests were administered for program evaluation purposes only.

Evaluation Instrument

Understanding was measured with a 20-item true/false test developed by the facilitation team from the workshop content, with four items for each of the five competency areas. Before use, the items were reviewed by one expert in educational evaluation. The same 20 items were administered immediately before the first session (pre-test) and at the end of the workshop

(post-test). Each correct answer scored one point. For each participant, the score in a competency area was the percentage of that area's items answered correctly; the area percentages reported in Table 2 are the means of these scores across the 45 participants. The overall figures of 60.6% and 87.8% are the unweighted averages of the five area means, which, because each area contains the same number of items, equal the mean percentage of correct answers on all 20 items.

Data Analysis

Data were drawn from observation, documentation, participant reflections, group discussion, and paired pre-test and post-test assessments. Analysis blended descriptive quantitative and qualitative strands. Only aggregated scores per competency area were retained after the workshop, so individual-level paired comparisons, such as a paired-samples *t*-test or a Wilcoxon signed-rank test, could not be computed. The quantitative strand is therefore descriptive: it reports pre-test and post-test means, the absolute gain in percentage points, and the average normalized gain, defined as the actual gain divided by the maximum possible gain (100 minus the pre-test mean), which allows areas with different baselines to be compared (Nissen et al., 2018). Because the evaluation used a single group without a comparison condition, these figures describe change in scores before and after the workshop and are not treated as evidence of a causal program effect. The qualitative strand drew on facilitators' observation notes, participants' reflections, and group discussion to interpret engagement, learning experience, and perceived benefit; recurring ideas were grouped into themes by the facilitation team.

RESULT AND DISCUSSION

Program Implementation

Implementation proceeded smoothly, with participants taking an active part. The workshop was facilitated by nine doctoral students of the UNJ Doctoral Program in Management Science, who jointly presented the theme *Building Effective Educational Leadership for Future Schools*. Lectures, interactive discussion, case studies, and collaborative problem-solving were interwoven to keep the learning experience concrete. Participants worked through the challenges that will confront future school leaders, including technological disruption, educational innovation, organizational change, teacher well-being, and the ethics of AI. The case discussions on classroom AI use addressed ethical questions, the security of student data, and the involvement of teachers in technology-based decision making. The

interactive segments invited participants to reflect on their own leadership and to test how each idea might play out in a school.

The workshop also introduced VUCA and traced its implications for school leadership, prompting participants to weigh responses to volatility, uncertainty, complexity, and ambiguity through adaptive leadership, collaborative decision making, and organizational agility (Heifetz et al., 2009; Taskan et al., 2022). Figures 1 to 4 record the plenary session, the delivery of materials, the interactive discussion, and participant engagement.



Figure 1. Plenary session of the ELEVATE 2026 program at Tunku Tun Aminah Library, Universiti Tun Hussein Onn Malaysia (22 June 2026). *Source: Documentation of the community service team, 2026.*



Figure 2. Delivery of leadership and digital literacy materials during the workshop. *Source: Documentation of the community service team, 2026.*



Figure 3. Interactive discussion and mentoring between facilitators and participants. *Source: Documentation of the community service team, 2026.*



Figure 4. Participant engagement during the capacity-building session. *Source: Documentation of the community service team, 2026.*

Change in Participant Understanding

All 45 participants included in the analysis completed both tests. Table 2 reports the mean pre-test and post-test scores, the absolute gain, and the normalized gain for each competency area.

Table 2. Change in participant understanding before and after the workshop ($n = 45$)

Competency area	Pre-test (%)	Post-test (%)	Gain (pp)	Normalized gain
Adaptive leadership	58	85	+27	0.64
AI literacy in education	55	88	+33	0.73
Data-driven decision making	60	84	+24	0.60
Collaborative and innovative culture	68	92	+24	0.75
Future school leadership perspective	62	90	+28	0.74
Average	60.6	87.8	+27.2	0.69

Source: Processed data, 2026. Normalized gain = (post-test – pre-test) / (100 – pre-test) (Nissen et al., 2018); the average row is computed from the average pre-test and post-test scores.

As Table 2 shows, average understanding rose from 60.6% before the program to 87.8% afterward, a descriptive increase of 27.2 percentage points, equivalent to a 44.9% relative increase and an average normalized gain of 0.69. Scores were higher on the post-test in all five areas. The largest absolute increase occurred in AI literacy (+33 percentage points). Expressed as normalized gain, however, the increases in collaborative and innovative culture (0.75), future school leadership perspective (0.74), and AI literacy (0.73) were of similar size, because the first two areas started from higher baselines. Normalized gain is known to favor groups with higher pre-test scores (Nissen et al., 2018), so these comparisons should be read with caution. Data-driven decision making showed the smallest gain on both measures (+24 points; 0.60). Two features of the instrument qualify these figures. With true/false items, a respondent guessing at random would be expected to score about 50%, so the pre-test mean of 60.6% lay only modestly above chance; and the identical items on both occasions may have made participants more familiar with the questions by the time of the post-test. As noted in the Method section, the change could not be tested for statistical significance with the aggregated data available.

Qualitative Observations

Facilitators' observation notes, participants' reflections, and the group discussions point to three recurring themes. The first concerns the framing of AI. In the case discussions, participants moved from describing AI mainly as a novel tool toward treating it as an instrument for improving teaching that must be weighed against fairness, privacy, the security of student data, and accountability. The second theme concerns evidence: participants increasingly described data as a basis for school decisions rather than as an administrative requirement. The third theme concerns shared leadership. Participants stressed the value of school cultures built on trust, innovation, continuous learning, and stakeholder engagement, and they connected these cultures to teacher well-being under technological change. In their

feedback, participants expressed strong satisfaction with the direct, hands-on experience the workshop offered and with the knowledge and skills they gained in using AI for teaching and learning.

Program Outputs, Benefits, and Sustainability

The program produced several concrete outputs. These comprise a set of workshop materials and case studies on adaptive leadership, ethical AI use, and data-driven decision making, together with the expert-reviewed 20-item assessment instrument, all of which can be reused by the partner institutions in later sessions. For participants, the workshop provided structured, hands-on exposure to leadership issues that are rarely treated together in initial teacher education, and the reflective discussion gave them an opportunity to relate these issues to their own future schools. For the partners, the program extended the academic network between UNJ and UTHM, and the UTHM side awarded a certificate of appreciation to the UNJ delegation. Sustainability has been given a formal basis: in August 2026, a letter of agreement (LoA) between the Faculty of Economics and Business (FEB), UNJ, and UTHM was signed, providing the framework for follow-up activities such as further capacity-building sessions and joint research. Figure 5 documents the community service team and participants.



Figure 5. Documentation of the community service team and participants (Group 1: Educational Leadership and School Management). *Source: Documentation of the community service team, 2026.*

Discussion

Taken together, the results suggest that participatory workshops which fuse leadership development with ethical AI literacy can support the readiness of future school leaders, although the single-group, aggregated design permits only a descriptive reading. Participants' understanding of adaptive leadership deepened, notably around the need to hold innovation, ethics, collaboration, and organizational effectiveness in balance. This mirrors the argument that adaptive challenges are met by mobilizing collective learning rather than applying routine

solutions (Heifetz et al., 2009), and that leadership capacity grows when responsibility is shared across a school community (Spillane, 2005).

The large absolute gain in AI literacy signals rising awareness of both the promise and the hazards of educational technology. Because the session was structured around the four aspects proposed by Ng et al. (2021), the qualitative observations can be read against them: participants' reframing of AI relates mainly to understanding AI and using it ethically, while their positive feedback on the hands-on experience corresponds to the using and applying aspect. That shift accords with reviews stressing that responsible AI in education depends on human-centered practice and on teachers' and leaders' knowledge for integrating AI-based tools ethically (Celik, 2023; Fu & Weng, 2024; UNESCO, 2021), and it speaks directly to the recurring concern that education stakeholders are underprepared for AI-rich environments (Bond et al., 2024; Ouyang et al., 2022).

Gains in data-driven decision making were the smallest of the five areas, yet they remain informative. Participants came to value evidence-based leadership and to see data as central to sound educational management, an outcome that resonates with work showing that data literacy must be built deliberately and then sustained through collaborative structures in which practitioners read evidence together and revise their practice (Mandinach & Gummer, 2016; O'Connor & Park, 2023). The comparatively modest gain is consistent with that work: interpreting data and acting on it is a skill that develops through repeated practice, which a single workshop can introduce but not consolidate.

Beyond the individual competencies, the program cultivated a fuller appreciation of collaborative leadership and organizational learning. Participants stressed the value of school cultures built on trust, innovation, continuous learning, and stakeholder engagement, the very dispositions suited to the volatile and ambiguous conditions of contemporary education (Taskan et al., 2022). The uneven baseline competence recorded at the outset squares with review evidence on pre-service teachers and shows why targeted, capacity-building interventions are worthwhile (Zhang et al., 2025).

Finally, the program advanced academic collaboration between Universitas Negeri Jakarta and Universiti Tun Hussein Onn Malaysia. Exchanging experiences and perspectives enriched participants' reading of leadership practice across ASEAN contexts and laid a foundation for continued cross-institutional work.

Several limitations should be kept in view. The evaluation used a single group without a comparison condition, so the higher post-test scores cannot be attributed to the workshop alone. The 45 participants were those assigned to and reached by one facilitation group out of

the 120 who attended, so they may not represent the full cohort. Only aggregated scores were retained, which ruled out paired significance testing, effect sizes at the individual level, and reliability estimation for the instrument, which was reviewed by a single expert. The identical true/false items, administered within the same day, are open to familiarity and guessing effects, and the immediate post-test captures short-term understanding rather than retention or changes in practice. The qualitative observations come from facilitators who also delivered the program. For these reasons, the findings are best read as indicative of the program's value rather than as generalizable causal claims.

CONCLUSION AND RECOMMENDATION

The program set out to strengthen pre-service teachers' understanding in five competency areas, namely adaptive leadership, AI literacy in education, data-driven decision making, collaborative and innovative culture, and future school leadership perspective, by treating them as one integrated agenda. Among the 45 participants who completed both assessments, mean understanding scores rose from 60.6% before the workshop to 87.8% afterward, with higher post-test scores in every area and an average normalized gain of 0.69. The qualitative observations indicate a more ethically grounded view of AI and a stronger appreciation of evidence-based and collaborative leadership. These descriptive results suggest that participatory leadership development of this kind can help prepare future teachers and school leaders for digital transformation, while the program's outputs and the letter of agreement signed in August 2026 provide a basis for continued collaboration between UNJ and UTHM.

Four recommendations follow. First, future initiatives should add longer-term mentoring so that competencies consolidate well beyond a single workshop. Second, participants would gain from practical, project-based AI tasks that convert awareness into applied skill, building on the hands-on experience they valued and extending it toward the evaluating and creating aspects of AI literacy. Third, the partner institutions should use the letter of agreement between FEB UNJ and UTHM signed in August 2026 to plan sustained professional growth and joint research. Fourth, subsequent programs should strengthen evaluation by retaining individual-level scores, using items with lower guessing probability, reporting instrument reliability, adding a delayed post-test and, where feasible, a comparison group, so that change can be tested statistically and its persistence observed.

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