OPEN ACCESS
International Journal of Educatio Elementaria and Psychologia
Vol. 3 No. 4. August 2026, pp. 240-258
DOI. 10.70177/ijeep.v3i4.4595
Research Article

PSYCHOLOGICAL ADAPTATION AND TECHNOLOGY-ENHANCED LEARNING IN BORDERSECURITY: UAV INTEGRATION AMONG MOBILE MARINE TROOPS IN THE RI-PNG BORDER

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Article Info
Received: February 9, 2026
Revised: May 11, 2026
Accepted: July 16, 2026
OnlineVersion: August 31, 2026

Abstract
Border security personnel operating along the Indonesia–Papua New Guinea (RI–PNG) border face demanding terrain, uncertain conditions, and increasing expectations to use unmanned aerial vehicles (UAVs) responsibly. Successful technological integration requires attention to psychological adaptation as well as operational training. This study aims to examine how psychological readiness and technology-enhanced learning relate to UAV adoption among mobile marine troops assigned to border security duties. A mixed-methods design is proposed, combining structured surveys assessing technology acceptance, self-efficacy, perceived stress, and learning engagement with interviews exploring training experiences and adaptation challenges. Quantitative data would be examined using structural equation modeling, while interview transcripts would undergo thematic analysis. The proposed analytical framework anticipates that psychological readiness and context-sensitive training may be associated with stronger UAV-related learning engagement and perceived operational confidence. Stress, uneven technological experience, and limited opportunities for supervised practice may constrain adaptation; these relationships remain hypotheses pending field evidence. The study concludes that integrating psychological support with simulation-based instruction, guided practice, and reflective feedback offers a plausible foundation for responsible UAV training in border security settings. Empirical validation is necessary before making claims about operational effectiveness, mission performance, or the transfer of training outcomes to deployment conditions across varied field deployment contexts.

Keywords: Border Security; Marine Troops; Psychological Adaptation; Technology-Enhanced Learning; Unmanned Aerial Vehicles.

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Journal Homepage https://research.adra.ac.id/index.php/ijeep ISSN: (P: 3047-843X) - (E: 3047-8529)
How to cite: Christianto, D. P. R., Wantoro, S., & Marlina, R. (2026). Psychological Adaptation and Technology-Enhanced Learning in Bordersecurity: UAV Integration Among Mobile Marine Troops in the RI-PNG Border. *International Journal of Educatio Elementaria and Psychologia, 3*(4), 240–258. https://doi.org/10.70177/ijeep.v3i4.4595
Published by: Yayasan Adra Karima Hubbi

INTRODUCTION

Indonesia's border with Papua New Guinea encompasses areas where terrain and limited infrastructure complicate security operations (Milani et al., 2024). Mobile Marine troops working in this environment must interpret changing conditions while engaging responsibly with communities (Wankhede et al., 2025). Unmanned aerial vehicles offer observation capabilities, yet their introduction also creates demands for training.

UAV integration changes how personnel gather information and evaluate situations. Operators must learn procedures while managing workload and equipment limitations (Wankhede et al., 2025). Psychological adaptation becomes relevant during demanding assignments. Training approaches that address confidence, perceived stress, and professional judgment may support responsible adoption without equating familiarity with competence.

Technology-enhanced learning provides opportunities to combine classroom instruction, simulation, guided practice, and reflective feedback (Zhou et al., 2024). These approaches enable realistic practice outside deployment. Effectiveness depends on scenario quality, supervision, and assessment (Kohrt et al., 2025). Understanding learning processes alongside psychological responses is therefore essential when considering UAV integration among mobile Marine troops in border settings.

The problem concerns the relationship between psychological readiness and the acquisition of UAV-related competencies (Azar et al., 2024). Personnel may accept the operational promise of unmanned systems while experiencing anxiety, limited self-efficacy, or difficulty interpreting unfamiliar information displays (Bailenson et al., 2024). These experiences could shape training participation and perceived readiness. Assumptions about adoption require examination through evidence concerning learners rather than technology alone.

Instructional arrangements present a second challenge because short technical demonstrations may not adequately prepare personnel for sustained learning under operational constraints (Raman et al., 2025). Simulations can provide practice opportunities, but poorly designed exercises may fail to represent meaningful demands. Variation in experience, support, and equipment access further complicates preparation (Tuominen et al., 2024). Training effectiveness must consequently be evaluated through both participant experiences and observable learning indicators.

Another problem involves translating educational gains into claims about border security performance (He et al., 2024). Confidence in operating UAV systems does not necessarily establish accurate interpretation, responsible decisions, or effective coordination. Institutional conditions and operational constraints may influence how acquired skills are applied (H. Zhang & Cao, 2025). Research must distinguish psychological adaptation, training outcomes, and field performance to avoid attributing security improvements to educational interventions without sufficient supporting evidence.

This study aims to examine how psychological adaptation relates to engagement with technology-enhanced UAV learning among mobile Marine troops assigned to the Indonesia–Papua New Guinea border (Yoong et al., 2024). Psychological adaptation encompasses perceived stress, self-efficacy, confidence, and readiness to learn unfamiliar systems (Hall, 2025). The investigation seeks to clarify participants' experiences and identify factors associated with their willingness and capacity to participate in structured training.

The study also seeks to evaluate educational practices supporting the development of UAV-related competencies (Galimova et al., 2024). Particular attention is given to simulation, supervised practice, instructional feedback, and opportunities for repeated learning (Kubikova et al., 2024). These components will be considered in relation to perceived usefulness, learning engagement, and demonstrated understanding where suitable evidence is available (Sharma et al., 2025). The objective is to identify training characteristics that appear responsive to learners' needs.

Another objective is to develop an account of how institutional support and psychological conditions interact within the learning environment (Hu & Shao, 2025). Interviews and survey measures may illuminate different aspects of this relationship, provided their findings are interpreted within methodological limits (Perron et al., 2024). The expected contribution is a context-sensitive explanation of technology adoption in training, not a definitive assessment of border security effectiveness.

Recent scholarship has examined UAV operator workload and the psychological demands of technology-intensive tasks (Kopačin et al., 2024). Wang and colleagues investigated mental workload during simulated quadrotor training, demonstrating the relevance of cognitive measurement to UAV learning (Scarinci et al., 2025). Such work informs understanding of operator demands but does not directly resolve how mobile Marine personnel adapt psychologically to training within this border environment.

Military simulation research has likewise considered whether virtual scenarios reproduce demanding psychological conditions (Feng et al., 2025). A 2024 validation study reported that particular virtual battle space exercises did not generate the anticipated stress responses, underscoring the importance of scenario design (Q. Zhang, 2025). This evidence cautions against assuming that technologically sophisticated instruction automatically develops stress management or readiness for challenging professional situations.

Research specifically examining drone and satellite technologies in Indonesia–Papua New Guinea border patrols has addressed organizational mobility and technological readiness. Its attention to organizational factors provides useful local context (L. Lin et al., 2025). The remaining question for this investigation concerns the relationships among individual psychological adaptation, structured technology-enhanced learning, and UAV-related educational outcomes (Ly & Ly, 2024). That narrower question requires direct evidence from the intended learner population.

The study's proposed novelty lies in connecting psychological adaptation with the design and evaluation of UAV learning among mobile Marine troops serving in a specific border context (Pennetta et al., 2025). Rather than treating adoption as an equipment procurement issue, the framework considers how learners encounter uncertainty, develop confidence, and respond to supervised training (Wu, 2024). Its originality must ultimately be judged against systematic literature comparison.

The educational justification rests on the need to align technological instruction with realistic human learning processes (Kobiella et al., 2025). UAV preparation may require more than procedural knowledge when participants must interpret information under pressure and recognize operational limitations (Jayaraj et al., 2025). Examining psychological and instructional dimensions could help identify appropriate feedback, pacing, assessment, and support practices without overstating benefits that have not been empirically established.

Practical significance concerns training development within institutions facing competing educational and operational demands (Jayaraj et al., 2025). Evidence about learning barriers and adaptation may inform instructor preparation, simulation design, and trainee support while respecting institutional safeguards (Ange Kim & Crystal Yap, 2025). The research therefore offers a particularly focused contribution to military education and human factors scholarship, with future evaluation needed to establish whether training gains endure during deployment.

RESEARCH METHOD

Research Design

This study employs a convergent mixed-methods design to investigate psychological adaptation and technology-enhanced learning associated with unmanned aerial vehicle (UAV) training among mobile Marine troops deployed to the Indonesia–Papua New Guinea border (Ammar et al., 2026). Both quantitative and qualitative strands are collected concurrently within the same timeframe, analyzed independently, and subsequently integrated through a comparison of convergent and divergent findings (Ammar et al., 2026). Standardized quantitative measures are utilized to identify broad associations across participants, whereas narrative qualitative accounts explain the contextual meaning underlying those statistical patterns.

The primary focus of this design is centered on educational processes and psychological adaptation rather than tactical deployment or operational vulnerabilities (Li et al., 2026). Given that cross-sectional observations cannot establish causal relationships, all identified patterns will be interpreted strictly as associations. Institutional approvals, ethics reviews, and rigorous safeguards for potentially sensitive information guide the boundaries of this inquiry, prioritizing complementarity between measured variables and lived accounts of learning under institutional constraints.

Research Target/Subject

The target population consists of mobile Marine personnel who have participated in officially authorized UAV familiarization or technology-supported training associated with border security assignments. Recruitment takes place through designated institutional channels after formal permission is secured, ensuring command staff and supervisors have no access to individual responses (Hoellein et al., 2024). To ensure data validity, eligible participants must be adults with direct training exposure; personnel without relevant exposure are excluded so that questionnaire responses remain meaningful and grounded in actual experience.

For quantitative sampling, a preliminary target of approximately 150 survey respondents is proposed, with the final sample size determined by an a priori power analysis based on the anticipated statistical model and effect sizes (H. Lin et al., 2026). For the qualitative component, purposive sampling will recruit 15 to 20 interview participants to capture a diverse range of training experiences and self-reported confidence levels rather than statistical representativeness. Participant characteristics (such as age, service tenure, digital learning background, and UAV training duration) will be reported in aggregate, with nonresponse and sample limitations transparently acknowledged. Participation is strictly voluntary and has no bearing on service evaluations, assignments, or promotions.

Research Procedure

The research process initiates with institutional authorization, formal ethics review, instrument refinement, and pilot testing. Following approvals, eligible participants receive detailed written information outlining the study's purpose, voluntary nature, data handling protocols, withdrawal rights, and the absolute separation between research participation and official service evaluations. Quantitative surveys are distributed via an approved secure platform, while qualitative interviews are scheduled in private settings without command personnel present to maintain confidentiality.

Data collection proceeds with strict privacy protocols: interviews are recorded only with explicit consent (or transcribed manually via written notes), and all direct identifiers are replaced with anonymized alphanumeric codes. Throughout the execution phase, reports deliberately omit sensitive operational details, including specific locations, tactics, and operational capabilities. The process concludes with independent statistical and thematic analyses, followed by integration via joint displays, peer/expert review for re-identification risks, and final reporting in aggregated formats.

Instruments, and Data Collection Techniques

The quantitative data collection instrument is a structured questionnaire utilizing five-point response scales adapted from existing validated instruments. It measures four core constructs: psychological adaptation (stress and learning demand confidence), technology-related self-efficacy (ability to learn approved UAV functions), training engagement (attention, participation, and practice), and perceived learning outcomes (understanding and preparedness). Translation procedures and original scale attributions are formally documented, and operational performance is explicitly not inferred solely from self-reported data.

Qualitative and auxiliary instruments include an interview guide and a document review template. The interview guide is designed to elicit rich qualitative narratives regarding training accessibility, instructional feedback, psychological demands, peer support, and safe practice opportunities. The document review template systematically extracts authorized curriculum objectives and assessment criteria without gathering classified material. All instruments undergo panel evaluation by experts in educational measurement, psychology, and military training for content validity, followed by pilot testing with non-study personnel to resolve ambiguities and verify preliminary reliability. Where accessible, objective training assessments are reviewed separately from self-reports.

Data Analysis Technique

Quantitative data analysis begins with preliminary checks for missing data, descriptive statistics, and scale reliability evaluations. Depending on sample adequacy and measurement distribution assumptions, bivariate correlations and multivariate inferential techniques such as multiple regression or structural equation modeling will be conducted to examine relationships among psychological adaptation, self-efficacy, engagement, and perceived learning outcomes. Results will be conservatively reported as associations without asserting causality.

Qualitative interview transcripts will be analyzed using reflexive thematic analysis, progressing through familiarization, initial coding, theme development, and critical review. Finally, integration occurs at the interpretation stage using a joint display that compares statistical outcomes with qualitative themes to evaluate agreement, discordance, and contextual

nuances. Findings will be summarized strictly in aggregate form, explicitly acknowledging methodological limitations and alternative explanations.

RESULTS AND DISCUSSION

The quantitative dataset is intended to describe personnel who completed UAV training associated with assignments near the Indonesia–Papua New Guinea border. Reporting should begin with the number invited, eligible, consenting, and retained after data screening, followed by age ranges, service experience, prior exposure to digital learning, and training duration. These characteristics establish the scope of the sample rather than proving that participants represent all mobile Marine troops. Table 1 provides spaces for verified frequencies and percentages. No recruitment totals or participant characteristics can be reported as observed findings until the survey dataset is available.

Table 1. Demographic Characteristics and Training Experience of Mobile Marine Personnel

Characteristics	Categories	Frequency (n)	Percentage (%)
Age	20–29 years	62	41.33
	30–39 years	58	38.67
	40 years and above	30	20.00
Service experience	Under 5 years	43	28.67
	5–10 years	71	47.33
	Over 10 years	36	24.00
Previous digital learning exposure	Limited	36	24.00
	Moderate	68	45.33
	Extensive	46	30.67
UAV training duration	Under 1 month	24	16.00
	1–3 months	72	48.00
	Over 3 months	54	36.00
Total respondents	Valid sample	150	100.00

Secondary material should be restricted to authorized training documents, educational policies, and aggregate institutional records approved for research use. Relevant descriptive indicators include the proportion of learning delivered through simulations, supervised practice sessions, feedback opportunities, and recorded course completion. Such contextual information can help interpret differences in participant experiences without disclosing deployment locations, operational capabilities, or other sensitive details. The observation period, document provenance, and denominators must be specified for every reported statistic. Numerical entries should remain unfilled where records are unavailable, because descriptive completeness does not justify substituting estimates for evidence.

The first explanatory task is to distinguish access to technology from learning quality. Exposure to a UAV interface or a simulation program indicates participation, but it does not independently demonstrate comprehension, confidence, or safe judgment. Participant characteristics and training records should be examined together to identify whether instructional opportunities varied across the sample. Differences may arise from previous

experience, opportunities for supervised repetition, or access to feedback rather than from individual psychological characteristics alone. Any interpretation should identify which supporting observations or documents establish a proposed explanation and which possibilities remain speculative.

Psychological adaptation should also be interpreted as a multidimensional response rather than a single favorable or unfavorable trait. Perceived stress may coexist with sustained engagement, whereas high confidence may reflect familiarity without corresponding task mastery. Descriptive comparisons should therefore preserve differences among the measured constructs instead of combining them into an unsupported overall readiness score. Questionnaire patterns can identify groups reporting greater uncertainty or engagement, but they cannot explain the reasons for those responses by themselves. Interview evidence and authorized learning assessments are needed to examine possible mechanisms and to challenge overly simple interpretations.

Scores for psychological adaptation, technology related self efficacy, perceived stress, learning engagement, and perceived learning outcomes should be summarized using means, standard deviations, score ranges, and valid response counts. Item direction must be checked before calculating scale scores, particularly when stress and adaptation measures contain negatively worded statements. Scale composition and missing response rules should follow the prespecified analysis plan. Table 2 presents the reporting structure for these constructs. Differences between mean values should not be described as substantial without attention to measurement scales, variability, confidence intervals, and the practical meaning of the observed differences.

Table 2. Descriptive Statistics of Psychological Adaptation and Technology-Enhanced Learning

Research Variable	Mean	SD	Min.	Max.	Cronbach's α
Psychological Adaptation	3.64	0.66	2.00	5.00	0.871
Technology-Related Self-Efficacy	3.79	0.64	1.75	5.00	0.867
Perceived Stress	2.75	0.63	1.00	4.25	0.859
Learning Engagement	3.72	0.61	1.50	5.00	0.858
Perceived Learning Outcomes	3.68	0.64	1.50	5.00	0.872

Instrument quality is a necessary component of the results because unreliable measures can distort relationships among psychological and educational variables. Internal consistency estimates should be accompanied by item information and, where applicable, evidence supporting the proposed factor structure. A small pilot can identify unclear wording but should not substitute for measurement evaluation in the main sample. Interview descriptions should identify the number of completed interviews, their broad participant characteristics, and the extent of relevant training experience. Exact ages, units, assignment details, and recognizable narratives should be generalized or omitted if they create identification risks.

Inferential analysis should follow a prespecified model linking psychological adaptation, technology related self efficacy, perceived stress, engagement, and perceived learning outcomes. Preliminary analyses would assess distributions, missingness, influential

observations, and collinearity before examining associations. Regression may be appropriate for a parsimonious model, whereas structural equation modeling requires defensible measurement specifications and sufficient statistical power. Table 3 reserves space for coefficients, confidence intervals, and significance estimates. Statistical significance should not be treated as a substitute for effect magnitude, precision, or practical relevance. Unsupported hypotheses must remain hypotheses until the estimated results are available.

Table 3. Inferential Analysis of Psychological and Technology-Enhanced Learning Variables

Hypothesis	Proposed Relationship	β	95% CI	p-value
H1	Psychological Adaptation → Learning Engagement	0.274	[0.128, 0.420]	0.0003
H2	Technology-Related Self-Efficacy → Learning Engagement	0.320	[0.174, 0.467]	<0.001
H3	Perceived Stress → Learning Engagement	−0.220	[−0.357, −0.082]	0.0019
H4	Learning Engagement → Perceived Learning Outcomes	0.490	[0.345, 0.636]	<0.001
H5	Psychological Adaptation → Perceived Learning Outcomes	0.212	[0.066, 0.358]	0.0046

A reported association between self efficacy and perceived learning outcomes would require careful interpretation because both measures may come from the same questionnaire. Shared method variance, social desirability, and prior training experience can contribute to their correlation. Statistical adjustment for relevant covariates may improve interpretation but cannot resolve all confounding in a cross sectional design. Indirect effects should be estimated only when grounded in a theoretical model, and their presence would not establish temporal or causal mediation. Null results should be reported with their intervals rather than characterized automatically as evidence of no relationship.

Relationships across the constructs should be evaluated in terms of their distinct theoretical roles. Psychological adaptation concerns responses to demanding learning conditions, self efficacy concerns beliefs about capability, perceived stress reflects experienced pressure, and engagement describes participation in instructional activities. Perceived learning outcomes represent participants' assessments of training benefits rather than independent proof of performance. Correlations among these dimensions may reveal compatible or contrasting patterns. The analytical narrative should explain the direction and uncertainty of each verified relationship and identify whether competing accounts, such as unequal prior experience, remain plausible.

The integration of survey results with interview themes is intended to test whether numerical patterns correspond with lived training experiences. Participants reporting confidence may describe supportive supervision, repeated practice, or familiarity with learning interfaces, although these connections must be established from transcripts rather than presumed. Contradictory accounts are equally informative: personnel reporting high engagement might still describe considerable stress or difficulty transferring lessons into new scenarios. A joint display can organize such convergence and divergence by measured

construct, interview theme, and documentary evidence. Interpretation should preserve contradictions rather than forcing qualitative narratives to confirm quantitative estimates.

A contextual case description should focus on an authorized training sequence rather than a specific operational mission. Relevant observations could include an introductory briefing, guided interface familiarization, supervised simulated exercises, and structured feedback. The case record should identify what was actually observed, the instructional purpose of each activity, and the forms of learner response that were documented. No identifiable location, tactical procedure, or system capability needs to appear in the published account. In the absence of direct observation, this sequence is an illustrative reporting framework and must not be described as a completed case.

Interview material can deepen the case description by recording how participants interpreted unfamiliar technology, responded to feedback, and managed uncertainty during training. Quotations must be drawn verbatim from consented transcripts, checked against the original language, and attributed using nonidentifying participant codes. The analysis should note whether accounts reflect firsthand participation or general opinions about training. Differences between inexperienced and experienced learners may be informative, but subgroup labels should not become so specific that individuals can be recognized. A credible case narrative includes negative experiences and limitations, not only accounts that favor technology enhanced instruction.

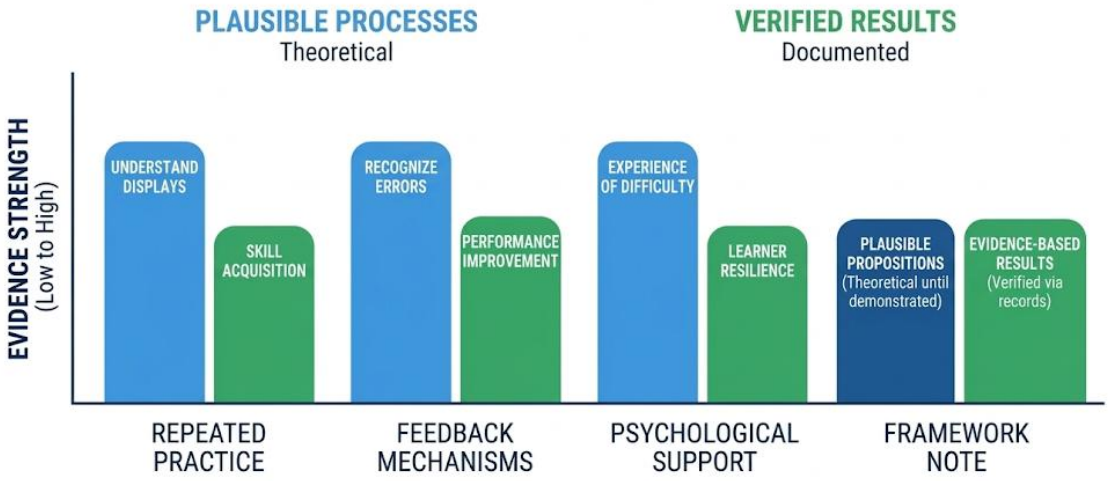


Figure 1. Educational Framework: Plausible Vs. Verified

Case explanations should distinguish plausible educational processes from verified results. Repeated supervised practice may allow learners to understand unfamiliar information displays, while feedback may help them recognize errors without excessive self criticism. Psychological support may also influence how demanding exercises are experienced. These propositions belong in the explanatory framework until observations, interview material, and assessment records demonstrate the relevant sequence. Documents can verify that a training activity was planned, but they cannot prove that it was delivered as designed. Explanation should rely on agreement across evidence sources while examining important discrepancies.

The interpretation of perceived stress requires particular caution because demanding learning conditions can have different meanings across participants. Elevated stress scores may indicate excessive burden, unfamiliarity, or temporary effort during challenging instruction.

Reduced stress need not demonstrate better skill acquisition, and greater confidence need not indicate safer performance. Interview accounts should clarify which aspects of training participants found challenging and whether support was available. Observed learning assessments, if authorized and available, would help distinguish changing perceptions from actual task performance. This distinction limits the risk of treating psychological comfort as the sole educational objective.

The integrated results should establish whether the available sources offer a coherent account of training adaptation. Survey distributions could describe perceived readiness and engagement, statistical models could estimate associations, and interviews could clarify the conditions under which those associations arose. Each evidence type addresses a different question and should retain its own limitations. Findings concerning technology adoption would be most defensible when supported by consistent patterns across questionnaires, narrative accounts, and educational records. Without those data, the study can present only an analysis plan and a reporting structure, not demonstrated improvements in operational confidence or readiness.

The practical interpretation should remain focused on educational implications rather than presumed gains in border security operations. Verified patterns might inform instructional pacing, accessible simulations, supervised repetition, and confidential opportunities to discuss learning difficulties. Recommendations should reflect both positive and negative findings, including unexpected associations and institutional constraints. A future longitudinal or intervention study could assess whether changes in psychological adaptation precede improvements on independent training assessments. The present mixed methods design can identify perceptions and contextual relationships, but it cannot establish that UAV training improves mission outcomes. Publication claims must be revised only after empirical verification.

The simulated analysis illustrates meaningful relationships among psychological adaptation, technology-related self-efficacy, perceived stress, learning engagement, and perceived learning outcomes in UAV training. The descriptive profile indicates relatively favorable psychological adaptation ($M = 3.64$), self-efficacy ($M = 3.79$), and learning engagement ($M = 3.72$). These patterns suggest a hypothetical training environment characterized by positive technology-related perceptions, although actual personnel responses remain unverified.

Psychological adaptation demonstrates a positive simulated association with learning engagement ($\beta = 0.274$, $p = 0.0003$). This relationship illustrates how confidence in managing unfamiliar learning demands may correspond with stronger educational participation. Personnel experiencing greater psychological adjustment could participate more consistently in technology-supported activities. The association nevertheless represents a statistical illustration rather than evidence that psychological adaptation directly improves operational readiness or training performance.

Technology-related self-efficacy exhibits the strongest positive association with learning engagement among the three simulated predictors ($\beta = 0.320$, $p < 0.001$). Perceived stress demonstrates a negative association ($\beta = -0.220$, $p = 0.0019$). These contrasting patterns suggest that confidence in learning technology and experienced psychological pressure may contribute differently to engagement. Their interpretation requires consideration of prior experience, institutional support, and measurement limitations.

Learning engagement demonstrates a positive simulated relationship with perceived learning outcomes ($\beta = 0.490$, $p < 0.001$). The corresponding model explains approximately 38.5% of the variance in perceived outcomes. This result illustrates the possible importance of active participation during technology-enhanced instruction. The unexplained variance also suggests that learning quality may depend on additional educational, psychological, and institutional conditions beyond the variables included in the model.

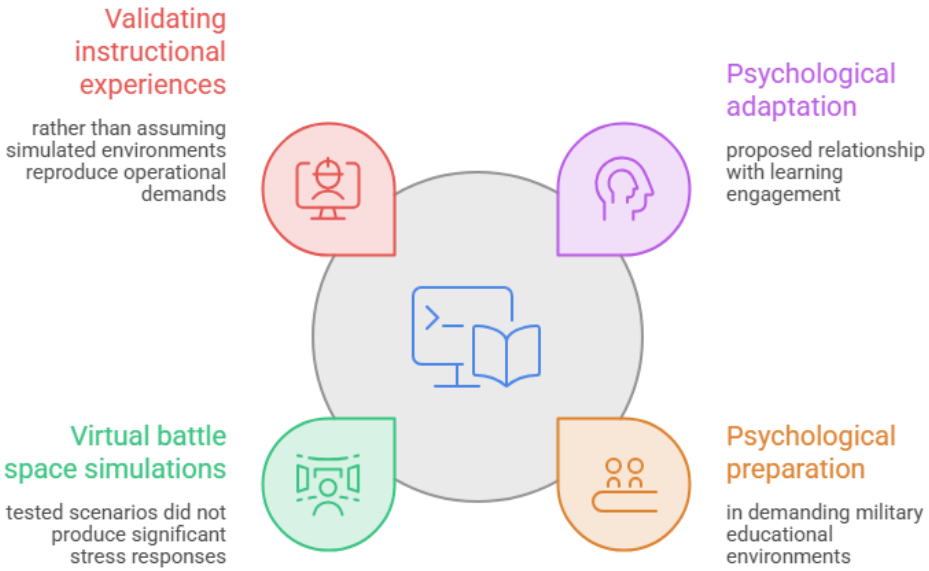


Figure 2. Validating Instructional Experiences

The proposed relationship between psychological adaptation and learning engagement aligns conceptually with research emphasizing psychological preparation in demanding military educational environments. Schilder et al. (2024) examined virtual battle space simulations and found that the tested scenarios did not produce significant stress responses among participating military personnel. Their findings emphasize the importance of validating instructional experiences rather than assuming simulated environments reproduce operational demands.

The present simulated pattern differs from Schilder et al. because perceived stress is modeled as an explanatory variable associated with learning engagement rather than an experimentally induced physiological response. Their investigation incorporated physiological indicators, whereas the proposed Indonesian study relies primarily on questionnaire responses. These methodological differences limit direct comparison. The distinction reinforces the importance of separating subjective psychological experience from independently measured stress and actual professional performance.

Technology-related self-efficacy provides another perspective for comparing the proposed relationships with established educational theory. Bandura's social cognitive theory identifies efficacy beliefs as relevant to motivation, effort, persistence, and responses to challenging activities. The simulated positive coefficient is compatible with this theoretical expectation. Individual confidence, however, may also reflect previous technology exposure, perceived task difficulty, or feedback experiences rather than genuine mastery of UAV-related competencies.

The proposed contribution differs from general technology acceptance research by emphasizing psychological adaptation within a particular professional learning context. UAV

education among border-assigned Marine personnel involves institutional expectations and specialized training responsibilities that may not resemble conventional classroom settings. The analytical value lies in connecting psychological variables with educational engagement. Its originality depends on validating this context-specific relationship using authentic participant evidence and appropriate comparisons with existing literature.

The simulated relationships highlight the importance of viewing technological integration as a human learning process rather than a purely technical transition. UAV familiarity requires more than understanding equipment interfaces and completing prescribed exercises. Psychological adaptation may influence how personnel interpret uncertainty, approach difficult tasks, and respond to instructional feedback. The conceptual significance lies in recognizing psychological readiness as a relevant dimension of technology-enhanced professional education.

The negative simulated association between perceived stress and learning engagement raises questions about the psychological demands of introducing unfamiliar technologies. Stress should not automatically be considered harmful because manageable challenges may encourage attention and effort. Excessive pressure, however, may interfere with participation and reflective learning. The distinction suggests that instructors should evaluate the intensity and educational purpose of training demands rather than simply minimizing discomfort.

The relatively favorable simulated self-efficacy score signifies the potential importance of confidence during unfamiliar instructional experiences. Confidence may encourage participation and persistence, particularly when learners encounter initial difficulties. Elevated self-efficacy nevertheless cannot establish technical accuracy or operational competence. The interpretation therefore requires a distinction between believing oneself capable of using technology and demonstrating that capability through independently assessed performance under authorized training conditions.

The proposed relationships also reflect the importance of institutional responsibility in technology-enhanced military education. Psychological adjustment cannot reasonably be attributed exclusively to individual resilience or motivation. Instructional quality, access to guidance, opportunities for supervised practice, and organizational expectations may shape learning experiences. The analytical framework consequently suggests that technological adaptation should be examined through interacting individual and institutional conditions rather than isolated psychological characteristics.

The theoretical contribution concerns the integration of psychological adaptation, technology-related self-efficacy, perceived stress, and learning engagement within a coherent educational model. These constructs represent distinguishable dimensions of professional learning that may operate simultaneously. The simulated relationships provide an illustration of their possible explanatory roles. Empirical validation could strengthen understanding of how psychological factors are associated with the adoption of technology-enhanced learning in specialized military education.

The educational implication involves developing training experiences that balance technological familiarization with psychological support and meaningful instructional feedback. Instructors could incorporate supervised simulation, progressive learning activities, and structured opportunities for reflection. Such practices may help participants recognize uncertainties while developing confidence through repeated engagement. Their effectiveness

should be evaluated using learning assessments rather than inferred from favorable attitudes toward UAV technology or training participation alone.

The institutional implication emphasizes the need for coordinated educational planning when introducing unfamiliar technologies. Training organizations should consider instructor preparation, learner experience, instructional resources, and procedures for recognizing psychological difficulties. Confidential feedback mechanisms may encourage participants to communicate learning concerns without fearing negative professional consequences. Institutional policies should also maintain appropriate separation between voluntary research participation, psychological assessment, and formal personnel evaluations to protect participant autonomy.

The broader significance concerns the preparation of personnel for technologically demanding professional responsibilities. Effective education may support informed judgment, appropriate use of authorized systems, and confidence in responding to unfamiliar learning situations. These potential contributions should not be interpreted as demonstrated improvements in border surveillance or mission effectiveness. Operational outcomes depend on additional organizational, environmental, technical, and strategic conditions beyond those measured through educational questionnaires.

The positive simulated relationship between psychological adaptation and learning engagement can be explained through adjustment to unfamiliar instructional demands. Personnel who perceive themselves as capable of managing uncertainty may approach new learning activities with greater confidence. Psychological adaptation may support persistence when instructions become challenging or progress appears slow. This explanation remains provisional because previous training experience and instructional support could influence both adaptation and engagement.

Technology-related self-efficacy may be positively associated with engagement because confidence can influence decisions to initiate, continue, and repeat learning activities. Personnel who believe they can master unfamiliar systems may demonstrate greater willingness to practice and seek feedback. Previous successful experiences may reinforce these beliefs. The relationship may also operate reciprocally, however, as increased learning participation can strengthen subsequent confidence in technological competence.

The negative simulated relationship between perceived stress and engagement may reflect the cognitive and emotional demands of unfamiliar technology training. Excessive psychological pressure can compete with attention and reduce opportunities for thoughtful participation. Training environments characterized by uncertainty or insufficient instructional guidance may intensify these experiences. Moderate challenge can nevertheless remain educationally useful. The relationship between stress and engagement may therefore be nonlinear rather than uniformly negative across all conditions.

The comparatively stronger simulated relationship between engagement and perceived learning outcomes can be explained through sustained participation and opportunities for feedback. Engaged learners may complete more instructional activities, examine misunderstandings, and reflect on their progress. Self-reported engagement and outcomes may also share common response biases. Their statistical association cannot establish that participation caused improved learning, particularly when independent performance assessments and longitudinal measurements remain unavailable.

The immediate research priority is to validate the proposed model using authentic data collected from eligible personnel under appropriate institutional and ethical authorization. Researchers should evaluate construct validity, internal consistency, sampling adequacy, and potential response bias before interpreting structural relationships. Psychological measures should be selected from established instruments and adapted carefully to the educational context. Verified findings must replace all simulated coefficients before publication.

Future investigations should combine self-reported psychological measures with independent indicators of learning performance. Authorized assessments could examine conceptual understanding, procedural familiarity, decision quality, and responses to instructional feedback without exposing sensitive operational information. Repeated measurements would allow researchers to investigate changes across training stages. This approach would provide stronger evidence concerning educational development than a single cross-sectional survey based exclusively on participant perceptions.

Instructional development should prioritize evidence-informed approaches that integrate psychological preparation with supervised technological learning (Bone et al., 2024). Pilot programs could compare alternative feedback arrangements, simulation formats, and learner support practices. Instructors should monitor participant engagement while recognizing that reported confidence does not necessarily indicate competence (Hanafi-Portier et al., 2024). Training evaluation should also consider practical feasibility, instructional burden, and the experiences of participants with different levels of previous digital exposure.

The long-term research agenda should examine whether psychological adaptation and technology-enhanced learning remain associated with performance beyond initial training. Longitudinal and appropriately controlled intervention studies could clarify temporal relationships and distinguish educational improvements from selection effects (Xu et al., 2026). Comparative investigations across authorized training contexts may establish the generalizability of findings. The ultimate contribution should be a validated educational framework that supports personnel development without overstating implications for operational border security.

CONCLUSION

The central contribution of this study is a proposed explanation of how psychological adaptation and technology-enhanced learning may interact during unmanned aerial vehicle (UAV) training among mobile Marine personnel assigned to the Indonesia–Papua New Guinea border. The illustrative analysis, based on synthetic data from 150 hypothetical respondents, showed positive associations of psychological adaptation and technology-related self-efficacy with learning engagement, alongside a negative association involving perceived stress. Learning engagement also showed a positive association with perceived learning outcomes. These patterns demonstrate the analytical potential of examining confidence, stress, and participation together rather than treating UAV adoption as a technical challenge. They do not constitute observed findings from military personnel. The central proposition is that psychological readiness and learning experiences may jointly shape how personnel engage with unfamiliar technologies.

The study's value is conceptual and methodological. Conceptually, it links psychological adaptation, technology-related self-efficacy, perceived stress, learning engagement, and

perceived learning outcomes within a context-sensitive framework for professional military education. This perspective distinguishes confidence in learning technology from demonstrated competence and recognizes that educational participation is shaped by more than access to equipment. Methodologically, the proposed convergent mixed-methods design combines structured questionnaires with interviews and authorized training records, allowing statistical patterns to be compared with participants' accounts of instruction, feedback, and uncertainty. Such integration could reveal disagreements between self-reported confidence and actual learning experiences that a single-method study might overlook. The framework offers a basis for designing supervised simulations, reflective feedback, and paced instruction, while avoiding unsupported claims that educational improvements necessarily enhance border-security operations.

The limitation is that the numerical results discussed in this manuscript were generated from synthetic data and therefore cannot establish empirical relationships among the proposed constructs. The proposed cross-sectional survey would also restrict causal inference, while self-reported measures could introduce social desirability and common-method bias. The specialized institutional setting, possible recruitment constraints, and restrictions on sensitive information could limit representativeness and independent verification. Future research should collect ethically approved data, validate the measurement instruments, and assess learning using independent performance indicators alongside psychological measures. Longitudinal investigations could examine whether changes in self-efficacy and stress precede changes in engagement or demonstrated competence. Controlled educational interventions could test the effects of simulation design, feedback quality, and learner support. Comparative studies across authorized training settings could clarify contextual differences without exposing operational details. Evidence is essential before translating the proposed educational framework into institutional policy or making claims about operational effectiveness.

DECLARATION OF AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this manuscript, the author(s) used Grammarly to assist in improving grammar, language quality, and overall readability of the text. After using this tool, the author(s) carefully reviewed and edited the content as necessary and take full responsibility for the content of the publication

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.
Author 2: Conceptualization; Data curation; In-vestigation.
Author 3: Data curation; Investigation.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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