Peer Digital Learning in an Indonesian Neighbourhood: Perceived Progress and Belonging Across Current Self-Assessed Digital Skill Levels

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Abstract

Peer digital learning is common outside formal courses, but its relationship with perceived outcomes may vary across current digital skill levels. This study examined whether Peer Digital Learning Engagement was associated with perceived Digital Learning Progress and Sense of Belonging in Peer Learning, and whether current Self-Assessed Digital Skills moderated both relationships. A cross-sectional survey included 217 purposively sampled participants aged 18–30 in Limo, Depok, Indonesia. Hierarchical regression and simple slope analysis were used. Peer Digital Learning Engagement was positively associated with both outcomes at the mean level of current skills. The interactions were significant but modest for Digital Learning Progress ($\beta = .179$, $p = .001$, $\Delta R^2 = .031$) and Sense of Belonging in Peer Learning ($\beta = .128$, $p = .038$, $\Delta R^2 = .016$). Both associations were positive at one standard deviation below and above the mean of current skills, but stronger above the mean. Digital Access Adequacy was not significant in either adjusted model. A sensitivity analysis using the single-item Retrospective Initial Digital Skills measure did not reproduce the interaction for Digital Learning Progress ($\beta = .081$, $p = .171$). The findings show differences in concurrent associations across current self-assessed skill levels. They do not establish temporal order, unequal learning gains, or a causal effect of starting digital skills. The conclusions are limited to the participants and local setting studied.

Keywords: ***peer digital learning; self-assessed digital skills; perceived digital learning progress; sense of belonging; digital inequality; Indonesia***

1. Introduction

Digital skills are now needed for study, work, public services, communication, and access to information. Still, frequent use of a smartphone or the internet does not necessarily mean that a person can judge information, protect personal data, solve practical problems, or create useful content. The digital divide therefore concerns more than devices and connections. Skills, readiness, social conditions, and the capacity to use technology meaningfully also matter (Badiuzzaman et al., 2025; Heponiemi et al., 2023; Lythreatis et al., 2022; Van De Werfhorst et al., 2022; Vassilakopoulou & Hustad, 2023). Even with similar access, people may report different digital outcomes alongside differences in purpose, skill, and confidence (Fang & Nie, 2025; Halim et al., 2025). Such variation has also been reported among Indonesian youth, despite their active online presence (Bulya & Izzati, 2024; Halim et al., 2024; Prasetiyo et al., 2021; Silvhiany et al., 2021).

Some digital learning takes place outside courses and classrooms. Young people ask friends for help, watch how others handle a task, share shortcuts, and discuss online problems. The idea of communities of practice views such learning as participation in shared activity (Lave & Wenger, 1991). Earlier studies have connected collaborative learning with digital skills (Kwiatkowska & Wiśniewska-Nogaj, 2022), and community-based platforms and projects with literacy, self-regulation, and creativity (Darmawan et al., 2025; Mashfufah et al., 2024). Community learning centres can also reach people who have limited access to formal learning opportunities (Belete et al., 2022; Dadang et al., 2026). For youth, social networks and shared digital spaces have been related to learning, civic participation, collective action, and responses to misinformation (Anwar et al., 2023; Nugroho, 2025; Saud et al., 2023; Wahyuningroem et al., 2024; S. Wang et al., 2026). In this study, Peer Digital Learning Engagement means everyday participation in learning or exchanging digital skills with peers. It does not require membership in a formal group or programme.

Peer interaction can provide practical occasions to ask questions, observe a solution, try an unfamiliar tool, or explain a method to someone else. These occasions may be related to how participants view their own learning. Digital Learning Progress is used here to mean perceived progress: participants' reports that their digital skills have grown or that they can perform tasks they could not do before. It is not an objective before-and-after measure. H1 is therefore framed as an association rather than an effect.

H1. Peer Digital Learning Engagement is positively associated with Digital Learning Progress.

The association between peer learning and perceived progress may vary with participants' current Self-Assessed Digital Skills. Digital divide research suggests that skills and readiness are related to how people use available opportunities (Ding & Ai, 2026; Heponiemi et al., 2023; Lythreatis et al., 2022; Van De Werfhorst et al., 2022; Vassilakopoulou & Hustad, 2023). The same concern appears in settings such as e-government and generative artificial intelligence, where access alone does not ensure a similar experience for users with different skills and confidence (Radojičić & Vukmirović, 2025; Suárez & García-Mariñoso, 2025; C. Wang et al., 2025). Participants reporting stronger current skills may find it easier to follow peer discussions, apply shared information, or contribute knowledge of their own. Those reporting lower skills may also engage, but the link between engagement and perceived progress may follow a different pattern. Current Self-Assessed Digital Skills are therefore examined as a moderator. They were measured at the same time as the other central variables and must not be read as skills established before peer learning began.

H2. The positive association between Peer Digital Learning Engagement and Digital Learning Progress is stronger at higher levels of current Self-Assessed Digital Skills.

Peer learning also has a social side. Asking a basic question, admitting confusion, offering help, and receiving recognition may be related to whether a person feels accepted and valued. Sense of belonging has been associated with engagement and continued participation in learning (Kelly et al., 2026; Tang et al., 2023; Xu & Brown, 2024). Work on inclusive learning likewise links participation and agency with learners' experience of inclusion (Lakkala et al., 2024), while studies of peer relations show that acceptance, rejection, and social comparison are related to belonging and self-efficacy (Li, 2025; Nie et al., 2024; Purwati et al., 2025). Current Self-Assessed Digital Skills may matter in this relationship because participants who feel more capable can contribute knowledge, take part more confidently, and receive acknowledgement from peers. This does not mean that participants reporting lower current skills cannot belong. It suggests only that the association between Peer Digital Learning Engagement and Sense of Belonging in Peer Learning may differ across current skill levels.

H3. The association between Peer Digital Learning Engagement and Sense of Belonging in Peer Learning is stronger at higher levels of current Self-Assessed Digital Skills.

Large-scale longitudinal work offers valuable accounts of young people's digital skills across settings (Machackova et al., 2024). This study turns to a narrower issue that cross-setting surveys do not directly address: everyday peer-

learning relationships within a specific local setting. It examines participants in Kelurahan Limo, Depok, asking whether Peer Digital Learning Engagement is associated with Digital Learning Progress and Sense of Belonging in Peer Learning, and whether these associations vary across current Self-Assessed Digital Skills. Its scope is limited to participants in this local setting. Figure 1 brings the three hypotheses together. H1 shows the proposed direct association with Digital Learning Progress, while H2 and H3 show moderation by current Self-Assessed Digital Skills. Because all central variables were reported in the same survey, every path represents a concurrent association. The model neither establishes temporal order or causality nor shows that stronger initial digital skills produced greater gains from peer learning.

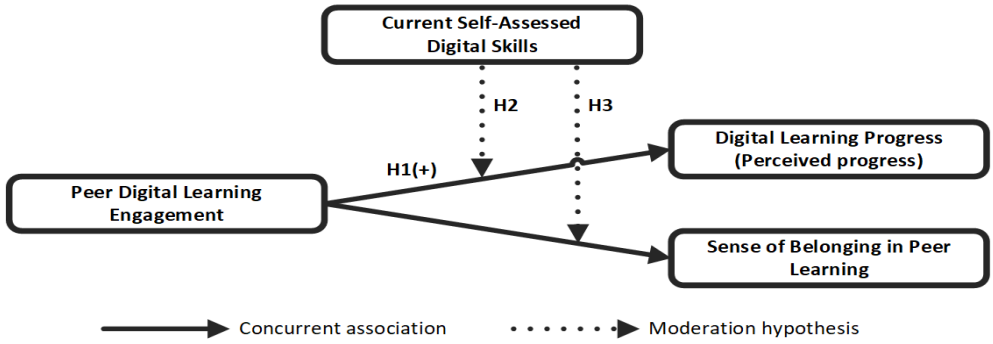


Figure 1: Research Model

Note. All paths represent concurrent associations. H2 and H3 test moderation by current Self-Assessed Digital Skills. The direct path to Sense of Belonging in Peer Learning is a lower-order association in the H3 regression model and is not a separate hypothesis. Other lower-order terms and control variables are omitted for clarity.

2. Methodology

2.1 Research Design

This study used a quantitative cross-sectional survey. Data were collected once from young adults who lived in Kelurahan Limo, Depok, and had experience learning or exchanging digital skills with peers. The analysis examined concurrent associations between Peer Digital Learning Engagement, current Self-Assessed Digital Skills, Digital Learning Progress, and Sense of Belonging in Peer Learning. It did not establish which variable came first or whether one variable caused another.

Two hierarchical multiple regression models were used. Digital Learning Progress was the outcome in the first model, while Sense of Belonging in Peer Learning was the outcome in the second. Current Self-Assessed Digital Skills was tested as a moderator in both models. Retrospective Initial Digital Skills was used only in a supplementary sensitivity analysis for Digital Learning Progress. It was not treated as a baseline measure.

2.2 Study Setting and Participants

The study was conducted in Kelurahan Limo, Depok City, Indonesia, within the wider Jakarta metropolitan region. The site represents a specific local neighbourhood and was not selected to represent Indonesian young adults more broadly. Digital devices, internet access, social media, and chat groups are common in daily life, but residents still differ in education, family background, digital experience, and confidence. The setting was therefore useful for examining peer digital learning where basic access was generally available but participants did not report the same level of digital skill.

Eligible participants were 18–30 years old, lived in Kelurahan Limo, and had learned or exchanged digital skills with friends, same-age neighbours, or peer chat groups at least once during the previous 12 months. Peer learning could include asking for help with an application, solving a device problem, sharing online search methods, checking information, creating content, or discussing online safety. Formal course or organization membership was not required.

2.3 Sampling, Recruitment, and Sample Size

No complete list was available for young adults in Limo who had participated in informal peer digital learning. The study therefore used purposive sampling, supported by limited referral recruitment. The questionnaire link was circulated through local community contacts across several neighbourhoods. Screening questions on age, residence, and prior peer digital learning appeared before the substantive items. This approach helped identify eligible participants, but it did not create a probability sample.

Data collection took place from May to June 2026. A total of 235 questionnaires were submitted. Eighteen were removed during screening: seven respondents did not live in Limo, four were outside the age range, four reported no peer digital learning during the stated period, and three questionnaires were incomplete. The final dataset contained 217 usable responses. In the final file, all 217 cases met both recorded eligibility flags and had complete data for every analysis variable. No additional final case was removed for a duplicated response vector or invariant responding.

No documented a priori power analysis was available in the study record. A sensitivity calculation was therefore used only to describe the capacity of the achieved sample. With N = 217, eight predictors in the final model, one tested interaction, $\alpha = .05$, and 80% power, the smallest detectable incremental effect was about $f^2 = .037$. For reference, detecting $f^2 = .040$ under the same settings would require 199 cases. These calculations do not make the non-probability sample representative.

2.4 Measurements

The questionnaire contained 21 items across five multi-item constructs, plus one single-item measure of Retrospective Initial Digital Skills and several screening and background questions. Table 1 reports the role, item codes, item focus, response scale, scoring, and conceptual sources for each substantive variable. Scores for the five multi-item constructs were calculated as the mean of their items, retaining the original 1–5 scale. Higher scores indicate a higher level of the construct. All items were positively worded, so no reverse scoring was required. A system-generated ID was used only for case checking and was not included in the analysis.

Different response scales were used depending on the type of question. Peer Digital Learning Engagement used a frequency scale, while Self-Assessed Digital Skills used a proficiency scale. Digital Learning Progress, Sense of Belonging in Peer Learning, and Digital Access Adequacy used agreement scales. The variables were also placed in different sections of the questionnaire. These choices were made to reduce repetitive answering. However, they could not fully address common method concerns because the predictor, moderator, control, and outcome variables were reported by the same respondents at the same time (Podsakoff et al., 2024).

Table 1: Complete map of substantive variables

Variable and role	Codes and item focus	Response and scoring	Conceptual sources
Peer Digital Learning Engagement (Predictor)	**KA1–KA5.** Frequency of learning digital skills with friends, asking peers for help, showing one another how to use devices or applications, joining digital-related conversations, and taking part in peer-learning opportunities.	1 = never to 5 = very often. Mean of five items.	(Lave & Wenger, 1991; Nugroho, 2025; Saud et al., 2023; S. Wang et al., 2026)
Self-Assessed Digital Skills (Current moderator)	**KD1–KD5.** Perceived ability to use devices and applications, search for information online, evaluate information accuracy, create digital content, and stay safe online.	1 = cannot do at all to 5 = can do very well. Mean of five items.	(Fang & Nie, 2025; Heponiemi et al., 2023; Machackova et al., 2024; Prasetiyo et al., 2021)
Digital Learning Progress (Outcome)	**KM1–KM4.** Perceived improvement over time, ability to perform tasks that were not previously possible, continued growth, and recent mastery of new digital skills. This construct reflects perceived progress, not an objective pre–post change score.	1 = strongly disagree to 5 = strongly agree. Mean of four items.	(Fang & Nie, 2025; Vassilakopoulou & Hustad, 2023)
Sense of Belonging in Peer Learning (Outcome)	**RD1–RD4.** Feeling part of the peer-learning circle, feeling accepted by peers, being comfortable asking questions or sharing without being belittled, and feeling valued for one's views or help.	1 = strongly disagree to 5 = strongly agree. Mean of four items.	(Kelly et al., 2026; Lakkala et al., 2024; Li, 2025; Tang et al., 2023; Xu & Brown, 2024)
Digital Access Adequacy (Control)	**AK1–AK3.** Availability of a usable digital device, ease of internet connection, and adequacy of quota, signal, and device for everyday online activity.	1 = strongly disagree to 5 = strongly agree. Mean of three items.	(Heponiemi et al., 2023; Van De Werfhorst et al., 2022; Vassilakopoulou & Hustad, 2023)
Retrospective Initial Digital Skills (Sensitivity moderator only)	**KD_awal.** General digital ability recalled for the time when the respondent first began learning digital skills frequently with friends.	1 = very low to 5 = very high. Single item; not included in reliability or CFA.	Author-developed retrospective item. It was interpreted as memory-based and not as a true baseline.

The screening and background variables, including their categories, coding, and use in the analysis, are shown in Table 2. The two screening variables were used only to determine eligibility. Age group, gender, parental education, and length

of involvement were used as control variables, while highest education was used only to describe the sample. The retrospective initial digital skills item was used only as a sensitivity moderator. Since it was a single retrospective item, it was not included in the reliability or CFA analysis.

Table 2: Screening, background variables, and exact analysis coding

Field	Recorded categories or coding	Use
Residence screen	Yes/No	Eligibility only. All 217 final cases = Yes.
Prior peer-learning experience	Yes/No	Eligibility only. All 217 final cases = Yes.
Age group	18–21 = 1; 22–25 = 2; 26–30 = 3	Ordered control; one linear trend coefficient.
Gender	Male = 0; female = 1	Binary control; male is the reference.
Highest education	Junior high or less; senior/vocational high; diploma; university or higher	Sample description only; not entered in the reported regressions.
Parental education	No schooling/primary = 1; junior high = 2; senior/vocational high = 3; diploma = 4; university or higher = 5	Ordered control; one linear trend coefficient.
Length of involvement	Less than 1 year = 1; 1–2 years = 2; more than 2 years = 3	Ordered control; one linear trend coefficient.

2.5 Instrument Development and Measurement Assessment

The measures drew on several sources and were adapted to ordinary peer digital learning rather than copied from one established scale. The first Indonesian draft was reviewed by two researchers familiar with information systems and digital literacy and by one local youth facilitator. It was then piloted with 15 young adults who matched the participant profile but were not included in the final sample. The pilot led to simpler wording and examples; no item was removed. The final wording kept the variable meanings shown in Table 1.

The measurement model was assessed in JASP using confirmatory factor analysis (CFA). A correlated five-factor model was specified for the 21 multi-item indicators. Each item loaded only on its intended construct; cross-loadings and correlated item residuals were fixed to zero. Maximum likelihood estimation was used with the sample covariance matrix. The five-category items were treated as approximately continuous after checking that no item showed severe univariate skewness or kurtosis.

Model fit was judged from the full pattern of results rather than the chi-square test alone. CFI and TLI values of .90 or higher and RMSEA and SRMR values of .08 or lower were used as practical guides. Standardized loadings of .50 or higher supported indicator quality. Internal consistency was assessed using Cronbach's alpha and McDonald's omega, with .70 as the minimum guide. Average variance extracted (AVE) was calculated as the mean squared standardized loading for each construct; values of .50 or higher supported convergent validity. Discriminant validity was checked by comparing the square root of each AVE with the construct's latent correlations and by requiring HTMT values below .85 (Roemer et al., 2021). Retrospective Initial Digital Skills was excluded from the CFA, alpha, omega, and AVE calculations because it was a single item.

2.6 Data Preparation and Analysis

The data were analysed in JASP. Initial screening checked the eligibility flags, missing values, exact duplicate response patterns, within-person response variation, and unusually long runs of the same response. Flagged patterns were reviewed together rather than treated as automatic reasons for deletion. The final dataset had complete values, so no imputation was used. Composite scores were calculated after checking the item direction and scale membership.

For each outcome, hierarchical ordinary least-squares regression was run in three blocks. Block 1 contained age group, gender, length of involvement, parental education, and Digital Access Adequacy. Block 2 added Peer Digital Learning Engagement and current Self-Assessed Digital Skills. Block 3 added their interaction. Peer Digital Learning Engagement and Self-Assessed Digital Skills were converted to z scores with the sample mean and sample standard deviation before the product term was calculated. Digital Access Adequacy and the ordered or binary controls remained in their recorded units.

H1 was examined through the Peer Digital Learning Engagement coefficient in the Digital Learning Progress model. Once the interaction was present, this coefficient represented the association at the mean of current Self-Assessed Digital Skills. H2 was tested by the interaction in the same model. H3 was tested by the interaction in the Sense of Belonging in Peer Learning model. Significant interactions were probed at one standard deviation below and above the mean of current Self-Assessed Digital Skills. Unstandardized coefficients (B), standard errors, standardized coefficients (β), t values, two-sided p values, and 95% confidence intervals were reported separately. R^2, adjusted R^2, change in R^2, and the F test for each change were also examined.

Regression checks covered linearity, residual spread, approximate residual normality, multicollinearity, and influential observations. Residual-versus-fitted and Q–Q plots were reviewed. Variance inflation factors, standardized residuals, leverage, and Cook's distance were checked. A case was not removed simply because one diagnostic was flagged; deletion required clear evidence that it was invalid or unduly determined the result.

The supplementary sensitivity model repeated the three-block Digital Learning Progress analysis after replacing current Self-Assessed Digital Skills with the standardized single-item Retrospective Initial Digital Skills score. The interaction was again the product of standardized Peer Digital Learning Engagement and standardized retrospective skill. Because this item depended on memory and was measured at the same survey occasion, the analysis was used only to check whether the interaction pattern was similar. It could not establish a starting level or temporal order.

2.7 Research Ethics

All participants were adults. Before starting the questionnaire, they received information about the study purpose, eligibility criteria, voluntary participation, anonymity, data use, and their right to stop at any time without penalty. The survey was anonymous and involved minimal risk. No names, identity numbers, detailed addresses, or other directly identifying information were collected. Formal institutional ethics review was not conducted for this study. The study was conducted in line with the ethical principles of the Declaration of Helsinki, and the results were analysed and reported in aggregate.

3. Results

3.1 Participant Profile and Data Completeness

The final dataset contained 217 eligible participants. All respondents reported living in Kelurahan Limo and having taken part in peer digital learning. No values were missing from the variables used in the analyses. Table 3 gives the participant profile.

Table 3: Respondent Profile (N = 217)

Variable/category	n	%
Age, years		
18–21	82	37.8
22–25	80	36.9
26–30	55	25.3
Gender		
Male	113	52.1
Female	104	47.9
Highest education		
Junior high school or lower	28	12.9
Senior or vocational high school	123	56.7
Diploma	26	12.0
University or higher	40	18.4
Parental education		
Primary school or no schooling	33	15.2
Junior high school	65	30.0
Senior or vocational high school	71	32.7
Diploma	26	12.0

University or higher	22	10.1
Length of involvement		
Less than 1 year	65	30.0
1–2 years	87	40.1
More than 2 years	65	30.0

Note: Percentages are based on N = 217. Percentages for length of involvement total 100.1% because of rounding.

3.2 Measurement Quality

The correlated five-factor CFA converged. The model produced $\chi^2(179) = 215.880$, $p = .031$, CFI = .987, TLI = .985, RMSEA = .031, and SRMR = .039. Standardized loadings ranged from .744 to .882. Reliability and average variance extracted (AVE) were acceptable for all five constructs, as shown in Table 4. The results also supported the distinctiveness of the five constructs. As shown in Table 5, the square roots of AVE were higher than the corresponding latent correlations, and all HTMT values were relatively low. The largest HTMT value was .513, suggesting that the constructs were sufficiently distinct from each other.

Table 4: Descriptive statistics and CFA-based measurement quality

Construct	Items	M	SD	Loading range	α	ω	AVE
Peer Digital Learning Engagement	5	3.41	0.90	0.779–0.836	0.902	0.903	0.651
Self-Assessed Digital Skills	5	3.49	0.89	0.795–0.816	0.902	0.903	0.649
Digital Learning Progress	4	3.54	0.93	0.799–0.882	0.916	0.917	0.735
Sense of Belonging in Peer Learning	4	3.65	0.95	0.836–0.869	0.914	0.914	0.727
Digital Access Adequacy	3	4.08	0.71	0.744–0.846	0.836	0.838	0.633

Note: Loadings are standardized CFA loadings. α = Cronbach's alpha; ω = McDonald's omega; AVE = average variance extracted.

Table 5: Construct distinctiveness: latent correlations, square roots of AVE, and HTMT

Construct	1	2	3	4	5
1. Engagement	(0.807)	0.373	0.513	0.434	0.076
2. Current skills	0.372	(0.806)	0.473	0.303	0.082
3. Progress	0.513	0.463	(0.857)	0.282	0.081
4. Belonging	0.432	0.304	0.276	(0.853)	0.073
5. Access	0.059	0.063	0.073	0.064	(0.795)

Note: Square roots of AVE appear in parentheses on the diagonal. Latent correlations are below the diagonal; HTMT values are above it. Constructs: 1 = Peer Digital Learning Engagement; 2 = Self-Assessed Digital Skills; 3 = Digital Learning Progress; 4 = Sense of Belonging in Peer Learning; 5 = Digital Access Adequacy. The largest HTMT value was .513.

3.3 Digital Access and Current Skills

Digital Access Adequacy was relatively high (M = 4.08, SD = 0.71). Mean scores were 4.18 (SD = 0.79) for access to a usable digital device, 4.10 (SD = 0.84) for ease of internet connection, and 3.97 (SD = 0.83) for the adequacy of quota, signal, and device for everyday online activity. Current skill ratings were higher for using devices and applications and searching for information online than for evaluating information accuracy, creating digital content, and staying safe online (Table 6).

Table 6: Current self-assessed digital skills by domain

Skill domain	M	SD
Using devices and applications	3.93	0.96
Searching for information online	3.85	1.00
Evaluating information accuracy	3.36	1.05
Creating digital content	3.17	1.09
Staying safe online	3.14	1.12

4. Regression Results

4.1 Digital Learning Progress

The control variables in Block 1 explained 13.0% of the variance in Digital Learning Progress, $R^2 = .130$, adjusted $R^2 = .110$, $F(5, 211) = 6.329$, $p < .001$. Adding Peer Digital Learning Engagement and current Self-Assessed Digital Skills raised R^2 to .371, $\Delta R^2 = .240$, $\Delta F(2, 209) = 39.886$, $p < .001$. The interaction added a further 3.1%, producing $R^2 = .402$, adjusted $R^2 = .379$, $\Delta R^2 = .031$, $\Delta F(1, 208) = 10.818$, $p = .001$.

In the final model, Peer Digital Learning Engagement was positively associated with Digital Learning Progress at the mean of current Self-Assessed Digital Skills (B = 0.337, SE = 0.055, β = .361, $p < .001$). This result was consistent with H1. The interaction between engagement and current skills was also positive (B = 0.171, SE = 0.052, β = .179, 95% CI [0.068, 0.273], $p = .001$), which supported H2 within the concurrent model (Table 7).

Table 7: Final regression model for Digital Learning Progress

Predictor	B	SE	β	t	p	95% CI for B
Intercept	2.625	0.348	—	7.551	< .001	[1.939, 3.310]
Age group	0.105	0.065	0.088	1.606	.110	[-0.024, 0.233]
Gender (female = 1)	0.069	0.103	0.037	0.669	.504	[-0.134, 0.271]
Length of involvement	0.259	0.067	0.215	3.843	< .001	[0.126, 0.391]
Parental education	0.106	0.045	0.132	2.336	.020	[0.017, 0.195]
Digital Access Adequacy	-0.043	0.072	-0.033	-0.601	.549	[-0.186, 0.099]
Peer Digital Learning Engagement	0.337	0.055	0.361	6.170	< .001	[0.230, 0.445]
Self-Assessed Digital Skills	0.233	0.057	0.250	4.075	< .001	[0.120, 0.346]
Engagement × current skills	0.171	0.052	0.179	3.289	.001	[0.068, 0.273]

Note: N = 217. $R^2 = .402$; adjusted $R^2 = .379$. B is unstandardized; β is standardized. The continuous focal predictors were standardized before the interaction was formed. Thus, the engagement coefficient is conditional on current skills at their sample mean.

4.2 Sense of Belonging in Peer Learning

For Sense of Belonging in Peer Learning, Block 1 explained 7.2% of the variance, $R^2 = .072$, adjusted $R^2 = .050$, $F(5, 211) = 3.264$, $p = .007$. Adding engagement and current skills increased R^2 to .222, $\Delta R^2 = .151$, $\Delta F(2, 209) = 20.242$, $p < .001$. The interaction added 1.6%, giving $R^2 = .238$, adjusted $R^2 = .209$, $\Delta R^2 = .016$, $\Delta F(1, 208) = 4.351$, $p = .038$.

In the final model, Peer Digital Learning Engagement was positively associated with Sense of Belonging at the mean of current skills (B = 0.311, SE = 0.063, β = .326, $p < .001$). The engagement × current skills interaction was positive but modest (B = 0.124, SE = 0.060, β = .128, 95% CI [0.007, 0.242], $p = .038$). This result supported H3 within the concurrent model (Table 8).

Table 8: Final regression model for Sense of Belonging in Peer Learning

Predictor	B	SE	β	t	p	95% CI for B
Intercept	2.925	0.399	—	7.327	< .001	[2.138, 3.711]
Age group	0.157	0.075	0.129	2.092	.038	[0.009, 0.304]
Gender (female = 1)	0.137	0.118	0.072	1.158	.248	[-0.096, 0.369]
Length of involvement	0.197	0.077	0.160	2.547	.012	[0.044, 0.349]
Parental education	-0.001	0.052	-0.001	-0.023	.982	[-0.104, 0.101]
Digital Access Adequacy	-0.015	0.083	-0.011	-0.182	.856	[-0.178, 0.148]
Peer Digital Learning Engagement	0.311	0.063	0.326	4.946	< .001	[0.187, 0.435]
Self-Assessed Digital Skills	0.133	0.066	0.140	2.020	.045	[0.003, 0.262]
Engagement × current skills	0.124	0.060	0.128	2.086	.038	[0.007, 0.242]

Note: N = 217. $R^2 = .238$; adjusted $R^2 = .209$. B is unstandardized; β is standardized. The engagement coefficient is conditional on current skills at their sample mean.

4.3 Simple Slopes and Model Diagnostics

The positive association between engagement and each outcome was present at both probed levels of current skills, but it was stronger at +1 SD than at −1 SD (Table 9).

Table 9: Simple slopes of Peer Digital Learning Engagement at two levels of current skills

Outcome	Current skills	B	SE	Std. slope	t	p	95% CI
Digital Learning Progress	Lower (−1 SD)	0.167	0.076	0.178	2.192	.029	[0.017, 0.316]
Digital Learning Progress	Higher (+1 SD)	0.508	0.075	0.544	6.785	< .001	[0.361, 0.656]
Sense of Belonging	Lower (−1 SD)	0.186	0.087	0.196	2.134	.034	[0.014, 0.358]
Sense of Belonging	Higher (+1 SD)	0.435	0.086	0.457	5.058	< .001	[0.266, 0.605]

Note: The engagement predictor was standardized. B is the expected change on the outcome scale for a one-SD increase in engagement at the stated level of current Self-Assessed Digital Skills. Confidence intervals are for B.
All VIF values were 1.31 or lower. The Breusch–Pagan tests did not indicate heteroscedasticity for Digital Learning Progress (p = .431) or Sense of Belonging (p = .549). Durbin–Watson values were 1.812 and 2.187, respectively. Progress residuals did not depart significantly from normality, W = .989, p = .112. The test was significant for belonging, W = .984, p = .015, although the residual plots showed only mild departure. Two cases exceeded the 3p/n leverage guide, but no studentized residual exceeded |3| and the largest Cook's distances were 0.149 and 0.046. The cases were retained.

4.4 Sensitivity Analysis Using Retrospective Initial Digital Skills

A sensitivity model replaced current Self-Assessed Digital Skills with the single-item Retrospective Initial Digital Skills measure. The overall model for Digital Learning Progress was significant, $R^2 = .336$, adjusted $R^2 = .310$, $F(8, 208) = 13.153$, $p < .001$. Peer Digital Learning Engagement remained positively associated with reported progress (B = 0.410, SE = 0.055, β = .439, $p < .001$). The interaction between Peer Digital Learning Engagement and Retrospective Initial Digital Skills was positive but not statistically significant (B = 0.075, SE = 0.054, β = .081, t = 1.374, 95% CI [−0.032, 0.181], p = .171). The sensitivity analysis therefore did not reproduce the moderation found with current Self-Assessed Digital Skills. This analysis was conducted only for Digital Learning Progress (Table 10).

Table 10: Sensitivity model for Digital Learning Progress using retrospective initial skills

Predictor	B	SE	β	t	p	95% CI for B
Intercept	2.432	0.364	—	6.681	< .001	[1.715, 3.150]
Age group	0.144	0.068	0.121	2.115	.036	[0.010, 0.278]
Gender (female = 1)	-0.018	0.107	-0.009	-0.164	.870	[-0.229, 0.194]
Length of involvement	0.259	0.071	0.215	3.667	< .001	[0.120, 0.398]
Parental education	0.163	0.047	0.203	3.479	< .001	[0.070, 0.255]
Digital Access Adequacy	-0.032	0.077	-0.025	-0.419	.676	[-0.184, 0.120]
PDL Engagement	0.410	0.055	0.439	7.402	< .001	[0.301, 0.519]
Retrospective initial skills	0.067	0.056	0.072	1.205	.230	[-0.043, 0.177]
Engagement × retrospective skills	0.075	0.054	0.081	1.374	.171	[-0.032, 0.181]

Note: N = 217. $R^2 = .336$; adjusted $R^2 = .310$. PDL = peer digital learning. The retrospective initial-skills measure was a single item. B is unstandardized; β is standardized.

5. Discussion

Peer Digital Learning Engagement was positively associated with both Digital Learning Progress and Sense of Belonging in Peer Learning. The association with each outcome was positive at lower and higher levels of current Self-Assessed Digital Skills, but it was stronger at the higher level. The interaction accounted for an additional 3.1% of the variance in Digital Learning Progress (β = .179) and 1.6% in Sense of Belonging in Peer Learning (β = .128). These findings were consistent with H1, H2, and H3 within the specified concurrent models. They do not show that participants who began

with stronger digital skills gained more from peer learning. Current skills, engagement, perceived progress, and belonging were all reported at the same survey occasion.

Digital Access Adequacy was relatively high and did not have a detectable independent association with either outcome after the other variables were included. This result should not be read as evidence that access is unimportant. It means only that access did not explain additional variation in these two models and in this sample. The pattern fits work showing that digital inequality extends beyond devices and an internet connection to skills, readiness, meaningful use, and the outcomes people report (Badiuzzaman et al., 2025; Fang & Nie, 2025; Heponiemi et al., 2023; Lythreatis et al., 2022; Van De Werfhorst et al., 2022; Vassilakopoulou & Hustad, 2023). Differences in digital outcomes can remain among people who have access but differ in skills and social background (Fang & Nie, 2025; Halim et al., 2025; Heponiemi et al., 2023). Related concerns have been reported in e-government and generative artificial intelligence, where nominal access does not ensure the same experience for every user (Radojičić & Vukmirović, 2025; Suárez & García-Mariñoso, 2025; C. Wang et al., 2025).

The findings are also compatible with the basic idea of communities of practice: learning is connected with participation in shared activity (Lave & Wenger, 1991). Earlier studies have linked collaborative or community-based learning with digital skills, self-regulated learning, creativity, and wider learning opportunities (Darmawan et al., 2025; Kwiatkowska & Wiśniewska-Nogaj, 2022; Mashfufah et al., 2024; S. Wang et al., 2026). The present study adds a narrower point. Among these participants, the strength of the association between peer engagement and the two reported outcomes varied with current self-assessed skills. Current skills may be related to how easily a person follows a discussion, tries a shared method, or contributes knowledge. The reverse direction is also plausible: earlier peer learning may already have shaped current skill ratings. The data cannot separate these possibilities or identify a mechanism.

The result for Sense of Belonging in Peer Learning deserves separate attention. Peer Digital Learning Engagement was positively related to belonging at both probed skill levels, so the result does not indicate that participants reporting lower skills were excluded. The association was simply weaker for them. This social outcome is relevant because peer learning involves asking for help, offering advice, and being recognised by others, not only exchanging technical information. Previous work links belonging with engagement and continued participation, and connects inclusive learning with participation, agency, and peer acceptance (Kelly et al., 2026; Lakkala et al., 2024; Li, 2025; Tang et al., 2023; Xu & Brown, 2024). Even so, Sense of Belonging in Peer Learning is not a general measure of social inclusion. The present result concerns feelings within peer-learning interaction and does not establish that digital skills cause belonging.

The size of the moderation effects limits the theoretical claim. The interaction terms were statistically significant, but their added explanatory power was modest. Current Self-Assessed Digital Skills are better treated as one relevant condition than as the main explanation for Digital Learning Progress or Sense of Belonging in Peer Learning. Other findings point in the same direction. Length of involvement was positively associated with both outcomes. Parental education was associated with Digital Learning Progress but not with Sense of Belonging in Peer Learning, while Digital Access Adequacy was not significant in either adjusted model. These mixed results are consistent with multilevel accounts of the digital divide, in which personal, family, and social conditions may relate differently to digital outcomes (Badiuzzaman et al., 2025; Van De Werfhorst et al., 2022). Ratings were higher for using devices and applications and searching for information online than for evaluating information accuracy, creating digital content, and staying safe online. This distinction matters because evaluating digital information requires more than routine device use (Brocca et al., 2024; Bruno et al., 2025).

The study did not test a training programme, so it cannot show which type of support works. The weaker association at lower current skill levels instead raises a practical question for future programme design. Basic mentoring, guided practice, room for simple questions, and active attention to participants who speak less are reasonable options to test. Social comparison also needs care because it may encourage some learners while discouraging others (Nie et al., 2024; Purwati et al., 2025). These ideas should be treated as design proposals, not as interventions validated by the present data.

Several limitations directly restrict what can be claimed. The cross-sectional design provides no temporal order. Digital Learning Progress was a perceived outcome rather than an objective pre-post change score, and Self-Assessed Digital Skills were not tested through performance tasks. The predictor, moderator, controls, and outcomes were reported by the same respondents at the same time. Separate questionnaire sections and different response formats may have reduced repetitive answering, but they did not remove common method concerns (Podsakoff et al., 2024). Unmeasured factors, including motivation, confidence, prior experience, or the quality of peer interaction, may also account for part of the observed pattern.

The sensitivity analysis gives a further reason for caution. When current Self-Assessed Digital Skills were replaced with Retrospective Initial Digital Skills, the interaction for Digital Learning Progress was not statistically significant (β = .081, p = .171, 95% CI [−0.032, 0.181]). The retrospective measure was a single memory-based item and was not a true baseline, but the non-significant result cannot be dismissed as a minor detail. It means that the moderation pattern was detected with current skills and was not reproduced with the alternative measure. This sensitivity analysis covered Digital Learning Progress only, not Sense of Belonging in Peer Learning. The purposive sample, limited referral recruitment, and single local setting also prevent statistical generalisation to all young adults in Kelurahan Limo, other Indonesian communities, or Indonesian young adults more broadly. Longitudinal studies should measure skills before peer-learning exposure, use direct skill tasks alongside self-reports, follow participation over time, and recruit broader probability-based samples. Such designs could test whether the moderation pattern persists and whether structured support changes it.

6. Conclusion

Among the 217 participants in this study, Peer Digital Learning Engagement was positively associated with perceived Digital Learning Progress and Sense of Belonging in Peer Learning. Both associations remained positive at lower and higher levels of current Self-Assessed Digital Skills, but they were stronger at the higher level. The interaction effects were modest, so current skills should be viewed as one condition linked to variation in these relationships, not as the main source of the outcomes. The non-significant coefficients for Digital Access Adequacy in the adjusted models do not show that access is irrelevant.

The central conclusion is limited but clear: this study found different concurrent patterns of association across current self-assessed skill levels. It did not show unequal learning gains, prove that stronger starting skills produce better outcomes, or establish a causal pathway. The interaction was not replicated for Digital Learning Progress when the single Retrospective Initial Digital Skills item was used, and no parallel retrospective test was conducted for belonging. Structured guidance may be worth testing in peer learning programmes, especially for participants who report lower skills, but its effectiveness remains an open question. The findings apply only to the participants and the local Indonesian setting studied. Stronger claims require longitudinal data, direct skill assessments, credible baseline measures, and broader sampling.

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