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Research Article

Algorithmic Literacy, Digital Literacy, and Perceived Digital Self-Efficacy as Predictors of Social Media Engagement Among Filipino Emerging Adults in the City of Manila

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ABSTRACT

The rapid spread of recommender algorithms has made the competencies that govern how young people interpret and act in digital spaces a pressing concern. This study examined levels of algorithmic and digital literacy, as well as perceived digital self-efficacy, among Filipino emerging adults and tested whether these competencies predicted their social media engagement. Using a descriptive-correlational and predictive design, a researcher-adapted survey was administered through non-probability sampling to 77 eligible emerging adults from the City of Manila. Given the non-probability sampling and ordinal data, levels were summarized using the median (*Mdn*) and interquartile range; associations were tested with Spearman's rank-order correlation; and predictors were identified through median (quantile) regression. Respondents showed a very high level of algorithmic literacy (*Mdn* = 4.50) and high levels of digital literacy (*Mdn* = 4.11), perceived digital self-efficacy (*Mdn* = 4.20), and social media engagement (*Mdn* = 3.83). All three competencies were significantly and positively associated with engagement: algorithmic literacy (ρ = .30, *p* = .003), digital literacy (ρ = .39), and perceived digital self-efficacy (ρ = .41), the latter two at *p* < .001. In the median regression, however, digital literacy was the only significant unique predictor of engagement (*b* = 0.47, *p* = .003); perceived digital self-efficacy and algorithmic literacy did not contribute uniquely once digital literacy was accounted for. Practical digital competence, rather than algorithm awareness or digital confidence alone, appears to most directly account for how emerging adults engage online, underscoring the value of competency-based digital citizenship programs.

Keywords: *Algorithmic Literacy, Digital Literacy, Emerging Adults, Perceived Digital Self-Efficacy, Philippines, Social Media Engagement*

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Introduction

The contemporary media environment is no longer organized solely by human editors but by computational systems that filter, rank, and recommend content for each user. Recommender algorithms now mediate what people see on social media, search engines, and streaming services, quietly shaping attention, opinion, and participation (Bucher, 2017; Eslami et al., 2015). For young people who have come of age inside these systems, the algorithm is not an abstraction but an everyday companion that curates their feeds, suggests their next video, and surfaces the news they encounter (Swart, 2021). Understanding how this generation perceives, understands, and acts within algorithmically governed spaces has therefore become central to debates on digital citizenship and media literacy.

Emerging adulthood, the developmental stage spanning roughly ages 18 to 29, is a period marked by identity exploration, instability, and intensive engagement with peers and information (Arnett, 2000). Members of this group are among the heaviest social media users, and the Philippines consistently ranks among the most active social media-using nations globally, with Filipinos spending some of the longest average daily hours online (Kemp, 2024). This combination of developmental openness and saturated connectivity makes Filipino emerging adults a theoretically and practically important population for studying the relationship between digital competencies and online engagement.

Algorithmic literacy refers to a user's awareness that algorithms shape online experiences together with the knowledge needed to recognize, interpret, and respond to their influence (Cotter & Reisdorf, 2020; Gran et al., 2021). Scholars have argued that an emerging algorithmic divide may compound existing digital inequalities because users who do not perceive algorithmic curation are less able to question, resist, or strategically use it (Cotter & Reisdorf, 2020; Gran et al., 2021). Recent measurement work has sought to capture this awareness systematically (Zarouali et al., 2021), yet evidence on how algorithmic literacy translates into actual patterns of engagement, particularly outside Western contexts, remains thin.

Digital literacy is a broader, multidimensional capability encompassing the ethical, informational, communicative, and creative skills required to use digital tools responsibly and effectively (Hobbs, 2010; Ng, 2012). It builds on a longstanding tradition of research on internet skills and the second-level digital divide, which has established that differences in online skills, not merely access, drive unequal online participation (Hargittai, 2002; van Deursen & van Dijk, 2011). It includes observing online etiquette, respecting intellectual property and privacy, evaluating the credibility of sources, and creating and sharing content. Alongside it, perceived digital self-efficacy, defined as a person's belief in their capacity to organize and execute the actions needed to attain a goal (Bandura, 1977, 1997), has been operationalized in digital settings as confidence in navigating, troubleshooting, and protecting oneself within online environments (Compeau & Higgins, 1995). Where digital literacy describes what users can do, self-efficacy captures how confident they feel about doing it, and both have been linked to richer, more deliberate technology use.

Social media engagement is increasingly understood as a multidimensional construct rather than a simple count of clicks. It spans behavioral engagement (observable actions such as liking, commenting, sharing, and participating in trends), cognitive engagement (the mental investment of attention, reflection, and critical evaluation), and affective or emotional engagement (the feelings of inspiration, connection, support, and satisfaction derived from online interaction; Di Gangi & Wasko, 2016; Dolan et al., 2016; Schaufeli et al., 2002). Treating engagement in this layered way allows researchers to distinguish superficial activity from the deeper, more meaningful forms of participation that competencies might foster.

Although each of these constructs has attracted scholarly attention, comparatively little research has examined them together within a single predictive model among Filipino emerging adults. It remains unclear whether algorithm awareness, digital literacy, and

perceived digital self-efficacy make independent contributions to engagement, or whether some of these competencies overshadow others. Clarifying this is important for designing digital-citizenship interventions that target the competencies that matter most.

The Present Study

This study aims to describe the levels of algorithmic literacy, digital literacy, and digital self-efficacy among Filipino emerging adults aged 18 to 29 in the City of Manila, to determine how each competency relates to their social media engagement, and to identify which competencies significantly predict that engagement. Specifically, the study addressed the following research questions:

1. What is the level of algorithmic literacy of the respondents?
2. What is the level of their digital literacy?
3. What is the level of their perceived digital self-efficacy in maneuvering the digital environment?
4. What is the level of their social media engagement?
5. What is the relationship between social media engagement and algorithmic literacy?
6. What is the relationship between social media engagement and digital literacy?
7. What is the relationship between social media engagement and perceived digital self-efficacy?
8. Which of these competencies significantly predict social media engagement?

Methods

Research Design

The study employed a quantitative, descriptive-correlational, and predictive research design. The descriptive component established the levels of the four focal constructs, the correlational component examined the bivariate relationships between each competency and social media engagement, and the predictive component used median (quantile) regression to determine the unique contribution of the competencies to engagement. This non-experimental design is appropriate for measuring naturally occurring variables and modeling their associations without manipulation.

Participants

Respondents were recruited through non-probability sampling—specifically, purposive and snowball sampling from the City of Manila. Eligibility required that participants (a) provided informed consent, (b) were emerging adults aged 18 to 29, and (c) completed all scale items. Of 191 form submissions, 88 incomplete or non-consenting entries and one declined consent were removed, and all remaining records satisfied the age and completeness criteria, yielding 102 respondents. Upon final review of these 102 respondents, those who reported not posting any material online during the week were removed, yielding a final analytic sample of 77 respondents. Because the sampling was non-probability, the results characterize this sample and are not statistically generalizable to the wider population of Filipino emerging adults. The profile of the respondents is summarized in Table 1.

Table 1. Digital-Use Profile of the Respondents

Variable	Category	*f*	%
Daily device use	≤ 4 hours	7	9.1
	5–8 hours	50	64.9
	9–12 hours	10	13.0
	13–24 hours	10	13.0
Posts created per week	1–2	48	62.3
	3–5	18	23.4
	6 or more	11	14.3

Note. n = 77. Median daily device use = 8.0 hours (*IQR* = 3.8); median weekly posts = 1 (*IQR* = 2). The most-used platforms were Instagram (93.1%), TikTok (86.3%), Messenger or WhatsApp (85.3%), YouTube (62.7%), and Facebook (56.9%); percentages exceed 100 because respondents could select multiple platforms.

Instrument

Data were gathered through a self-administered online questionnaire comprising a demographic section and four competency-and-engagement scales rated on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). Algorithmic literacy was measured using six items that captured awareness, understanding, recognition, explanation, bias awareness, and informed decision-making. Digital literacy was measured with nine items covering etiquette, intellectual property and privacy ethics, information gathering, source reliability, online participation, content creativity, and collaboration. Perceived digital self-efficacy in maneuvering the digital environment was measured with 10 items reflecting confidence in navigating, evaluating, communicating, creating, protecting personal information, and troubleshooting. Social media engagement was measured with 12 items distributed across three theoretically established subdimensions: behavioral (4 items), cognitive (4 items), and affective or emotional (4 items; Di Gangi & Wasko, 2016; Dolan et al., 2016; Schaufeli et al., 2002). As shown in Table 3, internal-consistency reliability ranged from acceptable to good for the three competency scales and the overall engagement scale (Cronbach's α = .74–.84 and .76, respectively), supporting the use of composite scores; subscale alphas for the engagement dimensions were lower and are reported alongside them.

Data Collection and Ethical Considerations

The survey questionnaire was distributed electronically. The first item presented the study's purpose, voluntary nature, confidentiality safeguards, and a consent statement; only respondents who affirmed consent and met the eligibility criteria proceeded to the substantive items. No personally identifying analysis was conducted, and responses were used solely for aggregate research purposes.

Data Analysis

Analyses were performed using Python with the pandas, SciPy, statsmodels, and pingouin packages. Composite scores for each construct were computed as the mean of their constituent items. Because participants were selected through non-probability sampling and the responses were ordinal, the variable levels were summarized using the median (*Mdn*) and interquartile range (*IQR*) rather than the mean and standard deviation. They were interpreted using the equal-interval ranges shown in Table 2.

The bivariate relationships posed in Research Questions 5 to 7 were tested using Spearman's rank-order correlation (ρ), the nonparametric analog appropriate for ordinal data drawn from a non-probability sample. To identify the significant predictors of social media engagement in Research Question 8, a median (quantile) regression was estimated on the composite scale scores. This rank-based estimator was chosen for consistency with the median and Spearman analyses and because, unlike ordinary least squares, it models the conditional median of the outcome, requires no assumption of normally distributed errors, and is robust to outliers and heteroscedasticity—properties well suited to ordinal data obtained through non-probability sampling. Model fit was summarized with the Koenker–Machado pseudo-R^2, and multicollinearity was assessed through variance inflation factors, all of which were below 2.0. Statistical significance was set at $p < .05$.

Table 2. Range of Scores and Interpretation of the 5-Point Likert Scale

Range of scores	Scale response	Competency level	Engagement level
4.21–5.00	Strongly agree	Very high	Very high
3.41–4.20	Agree	High	High

Range of scores	Scale response	Competency level	Engagement level
2.61–3.40	Neutral	Moderate	Moderate
1.81–2.60	Disagree	Low	Low
1.00–1.80	Strongly disagree	Very low	Very low

Note. Interpretation bands were applied to composite median scores.

Results and Discussion

Table 3 summarizes the median, interquartile range, reliability, and interpreted levels for the four focal variables and the three engagement subdimensions. Figure 1 presents the same construct levels against the interpretation bands. The results are organized below according to the study's research questions

Table 3. Levels, Dispersion, and Reliability of the Study Variables

Variable	*k*	*Mdn*	*IQR*	α	Interpretation
Algorithmic literacy	6	4.50	0.83	.84	Very high
Digital literacy	9	4.11	0.67	.74	High
Self-efficacy	10	4.20	0.80	.84	High
Social media engagement	12	3.83	0.58	.76	High

Note. N = 77. k = number of items; *Mdn* = median; *IQR* = interquartile range (Q3 − Q1); α = Cronbach's alpha. Interpretation follows the ranges in Table 2 and is based on the median

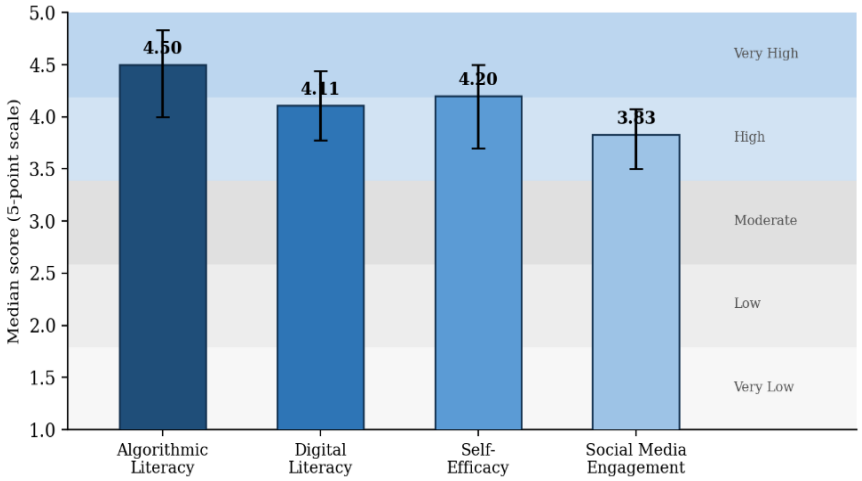

Figure 1. Median Levels of the Four Study Variables with Interquartile Range Bars. Note. N = 77. Bars represent the interquartile range (Q1–Q3); shaded regions correspond to the interpretation bands defined in Table 2.

Level of Algorithmic Literacy

The respondents reported a very high level of algorithmic literacy (*Mdn* = 4.50, *IQR* = 0.83), the highest among all variables examined. As detailed in Table 4, basic awareness that platforms use algorithms to curate content was effectively unanimous (*Mdn* = 5.00, *IQR* = 0.00), and the abilities to recognize algorithmically shaped recommendations and to make informed decisions about one's platform use likewise reached the scale ceiling (both *Mdn* = 5.00). The two most reserved items, though still positive, concerned confidence in explaining algorithmic influence on others and understanding the limitations and biases of algorithms (both *Mdn* = 4.00), with the explaining item showing the widest dispersion (*IQR* = 2.00). This pattern indicates that these emerging adults possess robust perceptual and conceptual awareness of algorithms but feel somewhat less assured in articulating that knowledge to others. The finding is consistent with research suggesting that younger, highly connected users have developed a vivid

algorithmic imaginary through daily platform experience (Bucher, 2017; Swart, 2021), and it echoes evidence that explanatory or technical fluency lags behind basic awareness (Gran et al., 2021).

Table 4. Item-Level Analysis of Algorithmic Literacy

Indicator	*Mdn*	*IQR*	Level
Aware that platforms use algorithms to decide content	5.00	1.00	Very high
Understand how algorithms work (data, prediction, outcomes)	5.00	1.00	Very high
Recognize when an algorithm shapes a feed or result	5.00	1.00	Very high
Confident in explaining algorithmic influence to others	4.00	2.00	High
Understand the limitations and biases of algorithms	4.00	1.00	High
Capable of informed decisions about platform engagement	5.00	1.00	Very high
Overall	**4.50**	**0.83**	**Very high**

Note. n = 77. *Mdn* = median; *IQR* = interquartile range (Q3 − Q1). Interpretation follows the ranges in Table 2 and is based on the median.

Level of Digital Literacy

Respondents demonstrated a high level of digital literacy (*Mdn* = 4.11, *IQR* = 0.67). Table 5 shows that the ethical and informational dimensions were especially strong, with awareness of plagiarism and copyright consequences showing near-unanimous agreement (*Mdn* = 5.00) and etiquette, information gathering, consent awareness, respect for terms and conditions, and reliance on reputable websites all reaching the very high band (each *Mdn* = 5.00).

Table 5. Item-Level Analysis of Digital Literacy

Indicator	*Mdn*	*IQR*	Level
Observe proper online etiquette	5.00	1.00	Very high
Aware of plagiarism and copyright consequences	5.00	1.00	Very high
Gather information from various sources to solve problems	5.00	1.00	Very high
Seek consent before sharing personal information	5.00	1.00	Very high
Respect the terms and conditions of online resources	5.00	1.00	Very high
Use reliable, well-known websites for information	5.00	1.00	Very high
Actively participate in online polls and surveys	3.00	2.00	Moderate
Apply creativity in curating content and posts	4.00	2.00	High
Closely collaborate with other social media users	3.00	2.00	Moderate
Overall	**4.11**	**0.67**	**High**

Note. n = 77. *Mdn* = median; *IQR* = interquartile range (Q3 − Q1). Interpretation follows the ranges in Table 2 and is based on the median.

The construct's overall level was tempered by two participation-oriented items that fell into the moderate band: active participation in online polls and surveys and close collaboration with other social media users (both *Mdn* = 3.00, *IQR* = 2.00). In other words, these emerging adults are conscientious and information-savvy digital citizens, yet they are more reserved when it comes to overtly participatory or collaborative behaviors. This mirrors the multidimensional view of digital literacy in which ethical and information subskills can be well developed even as communicative-participatory skills remain comparatively underused (Hobbs, 2010; Ng, 2012).

Level of Self-Efficacy in Maneuvering the Digital Environment

The respondents also reported a high level of perceived digital self-efficacy (*Mdn* = 4.20, *IQR* = 0.80). Table 6 indicates that confidence was greatest for protective and navigational tasks—awareness of online dangers and risks, knowing how to navigate social media to find specific information, and knowing how to protect personal information (all *Mdn* = 5.00)—which reached the very high band.

Table 6. Item-Level Analysis of Perceived Digital Self-Efficacy in the Digital Environment

Indicator	*Mdn*	*IQR*	Level
Know how to navigate social media to find specific information	5.00	1.00	Very high
Aware of the dangers and risks of online environments	5.00	1.00	Very high
Know how to protect personal information online	5.00	1.00	Very high
Confident in differentiating factual from misleading information	4.00	2.00	High
Familiar with engaging in online discussions and discourse	4.00	2.00	High
Confident in defending oneself and others against online injustice	4.00	2.00	High
Able to create and publish content on social media	4.00	2.00	High
Knowledgeable in the technical aspects of content creation	4.00	2.00	High
Can resolve technical problems encountered online	4.00	2.00	High
Can identify technical problems when using social media	4.00	2.00	High
Overall	**4.20**	**0.80**	**High**

Note. n = 77. *Mdn* = median; *IQR* = interquartile range (Q3 − Q1). Interpretation follows the ranges in Table 2 and is based on the median.

Confidence was comparatively lower, though still high, for the more generative and discursive tasks such as engaging in online discussions, creating and publishing content, and knowing the technical aspects of content creation (each *Mdn* = 4.00, *IQR* = 2.00). Thus, respondents felt most efficacious as careful, self-protective navigators and slightly less so as content producers and public discussants. This profile aligns with social-cognitive theory, in which perceived digital self-efficacy is domain specific and built primarily through mastery experiences (Bandura, 1977, 1997), and with operationalizations that treat perceived digital self-efficacy as confidence in concrete online tasks (Compeau & Higgins, 1995).

Level of Social Media Engagement

Table 7 shows that the social media engagement was high overall (*Mdn* = 3.83, *IQR* = 0.58).

Table 7. Item-Level Analysis of Social Media Engagement by Subdimension

Indicator	*Mdn*	*IQR*	Level
Behavioral engagement	**3.50**	**1.19**	**High**
Engage with posts (like, comment, share)	5.00	1.00	Very high
Mention friends in posts	3.00	2.00	Moderate
Participate in trends	3.00	2.00	Moderate
Use social media while doing other tasks	4.00	2.00	High
Cognitive engagement	**4.00**	**0.94**	**High**
Use social media for news and updates	5.00	1.00	Very high
Reflect on the meaning of consumed content	4.00	2.00	High
Critically evaluate the source and quality of information	4.00	2.00	High
Posts interacted with influence my opinion	4.00	2.00	High
Affective engagement	**4.00**	**1.25**	**High**
Inspired by content consumed	4.00	2.00	High
Sense of connection to online communities	4.00	2.00	High
Sense of support or validation	4.00	2.00	High
Overall satisfaction with interactions	4.00	2.00	High
Overall engagement	**3.83**	**0.58**	**High**

Note. n = 77. *Mdn* = median; *IQR* = interquartile range (Q3 − Q1). Interpretation follows the ranges in Table 2 and is based on the median.

Examining the subdimensions reveals an informative ordering: cognitive and affective engagement were both higher (each *Mdn* = 4.00) than behavioral engagement (*Mdn* = 3.50). Within the behavioral dimension, liking, commenting, and sharing reached the ceiling (*Mdn* = 5.00), yet participating in trends and mentioning friends in posts were only

moderate (both *Mdn* = 3.00). The strongest items across the entire engagement scale were using social media for news and updates and engaging with posts (both *Mdn* = 5.00), reinforcing that these emerging adults treat platforms as informational as well as social spaces while engaging more through consumption and selective interaction than through performative, trend-following activity. The layered pattern—strong cognitive and affective involvement alongside more measured behavioral output—supports multidimensional models of engagement that distinguish internal involvement from observable action (Di Gangi & Wasko, 2016; Dolan et al., 2016; Schaufeli et al., 2002).

Relationships Between the Competencies and Social Media Engagement

Research Questions 5 through 7 examined the relationships between social media engagement and each competency. Given the non-probability sample and the ordinal nature of the data, Spearman's rank-order correlation was used. As shown in Table 8, all three correlations were positive and statistically significant. Perceived digital self-efficacy showed the strongest association with engagement (ρ = .41, $p < .001$), followed closely by digital literacy (ρ = .39, $p < .001$) and then algorithmic literacy (ρ = .30, $p = .003$). By conventional benchmarks, these associations range from weak to moderate, indicating that emerging adults who are more digitally confident, more digitally competent, and more algorithm-aware tend to engage more fully with social media. The comparatively weaker role of algorithmic literacy foreshadows the regression results below, and it is consistent with the view that practical competence and confidence translate more directly into participation than awareness alone (Compeau & Higgins, 1995; Ng, 2012).

Table 8. Spearman Rank-Order Correlations Between the Competencies and Social Media Engagement

Predictor variable	ρ	*p*	Strength	Decision
Algorithmic literacy	.30	.003	Weak	Significant
Digital literacy / competency	.39	< .001	Moderate	Significant
Self-efficacy	.41	< .001	Moderate	Significant

Note. $n = 77$. Criterion variable = social media engagement. ρ = Spearman's rho. Strength benchmarks: ρ < .30 = weak, .30–.49 = moderate, .50–.69 = strong; classifications are based on unrounded coefficients (algorithmic literacy ρ = .295).

Significant Predictors of Social Media Engagement

To address Research Question 8, the three competencies were entered simultaneously as predictors of social media engagement in a median (quantile) regression, the multivariable extension of the median used throughout the descriptive analysis. As Table 9 and Figure 2 show, digital literacy was the only significant unique predictor: A one-point increase in digital literacy was associated with a 0.47-point increase in the conditional median of engagement, 95% CI [0.16, 0.77], $p = .003$. Neither self-efficacy ($b = 0.12$, 95% CI [−0.16, 0.40], $p = .395$) nor algorithmic literacy ($b = 0.04$, 95% CI [−0.23, 0.32], $p = .764$) contributed uniquely once digital literacy was accounted for. The model's Koenker–Machado pseudo-R^2 was .09, and all variance inflation factors were below 2.0, indicating no multicollinearity.

This multivariable result refines the bivariate picture. Although all three competencies were individually correlated with engagement (Table 8), they were moderately intercorrelated (ρ = .44–.57); once their shared variance is considered, digital literacy accounts for the predictive contribution of the other two. In practical terms, the broad repertoire of ethical, informational, and communicative skills captured by digital literacy—rather than algorithm awareness or digital confidence on their own—most directly accounts for the ways in which emerging adults engage with social media. This finding extends algorithmic-divide

arguments (Cotter & Reisdorf, 2020; Gran et al., 2021) by showing that among already highly connected young users, practical digital competence, rather than mere awareness of algorithms, differentiates levels of engagement.

Table 9. Median (Quantile) Regression Predicting Social Media Engagement from the Three Competencies

Predictor	***b***	**95% CI**	***p***
Constant	1.245	[0.14, 2.35]	.028
Algorithmic literacy	0.041	[−0.23, 0.32]	.764
Digital literacy / competency	0.468	[0.16, 0.77]	.003
Self-efficacy	0.120	[−0.16, 0.40]	.395

Note. n = 77. Conditional-median regression (q = 0.50) estimated on composite scale scores; criterion = social media engagement. b = unstandardized regression coefficient; CI = confidence interval. Koenker–Machado pseudo-R^2 = .09; all variance inflation factors < 2.0. This rank-based estimator is consistent with the median and interquartile range descriptives, as well as the Spearman correlations reported above, and does not assume normally distributed errors. Only digital literacy is significant at $p < .05$.

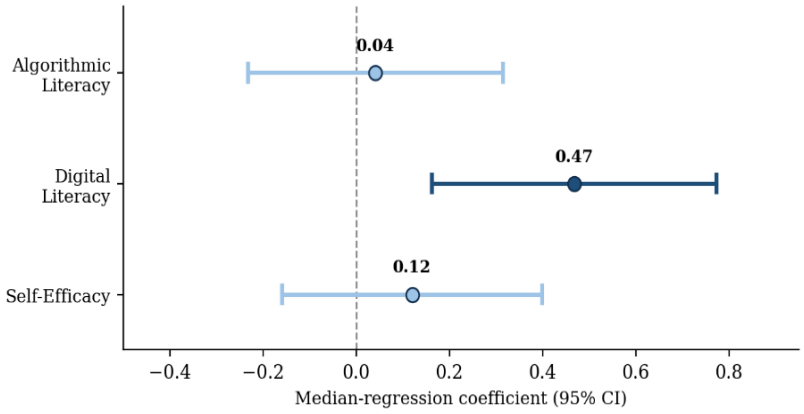

Figure 2. Median-Regression Coefficients With 95% Confidence Intervals for the Three Competencies. Note. n = 77. Points represent unstandardized coefficients and horizontal lines represent 95% confidence intervals. Intervals crossing zero (dashed line) indicate nonsignificant unique predictors; only digital literacy is significant.

Conclusion

This study profiled the digital competencies (algorithmic literacy, digital literacy, perceived digital self-efficacy) of Filipino emerging adults in the City of Manila. It examined their relationships with social media engagement. The respondents emerged as highly capable digital citizens: Their algorithmic literacy was very high, whereas their digital literacy, perceived digital self-efficacy, and social media engagement were all high. Engagement was driven more by cognitive and affective investment—especially through news platforms and the inspiration they provided—than by performative behaviors such as following trends. Using a single, consistent nonparametric strategy appropriate for the ordinal, non-probability data, all three competencies were significantly and positively related to engagement at the bivariate level. Still, the median-regression analysis told a sharper story: Digital literacy was the only significant unique predictor of engagement. In contrast, perceived digital self-efficacy and algorithmic literacy—though each was positively correlated with engagement—added no unique predictive value once digital competence was accounted for.

The central implication is that fostering meaningful, healthy online engagement among

emerging adults depends less on raising their awareness of algorithms and more on equipping them with practical digital skills and the confidence to use them. Educators and digital-citizenship programs should therefore emphasize hands-on competence in evaluating, creating, communicating, and self-protecting online, using mastery-oriented activities that strengthen self-efficacy.

Limitations and Directions for Future Research

Several limitations temper these conclusions. The sample was modest in size, geographically concentrated, and drawn through non-probability sampling, so the findings describe this group rather than generalize to all Filipino emerging adults. The data were cross-sectional and self-reported, precluding causal inference, and the digital-literacy and self-efficacy items were grouped on conceptual grounds in the absence of an explicit instrument blueprint. Future research should test the model with larger, more diverse probability samples; validated, clearly delineated scales; and longitudinal or experimental designs. It should also explore mediating mechanisms, such as how perceived digital self-efficacy converts awareness into action, as well as the distinct antecedents of behavioral, cognitive, and affective engagement.

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