

From Need Satisfaction to Participatory Digital Citizenship: Motivational Pathways and Configurations among Chinese Undergraduates

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Abstract

Participatory digital citizenship requires students to move beyond technical competence and safe use toward constructive contribution in digitally mediated communities. Yet the motivational processes that connect university learning with such contribution remain underexplored, particularly in Asian higher education. This cross-sectional study examined associations among psychological need satisfaction, academic self-efficacy, learning engagement, and online civic engagement in 9,929 Chinese undergraduates nested in 49 academic-program recruitment groups. Standardized composite-score path models used cluster-robust inference, and a complementary fuzzy-set qualitative comparative analysis identified sufficient configurations. Need satisfaction was positively associated with self-efficacy and engagement, self-efficacy was additionally associated with engagement, and all three constructs were positively associated with online civic engagement; engagement had the largest direct association. The serial indirect association through self-efficacy and engagement was also positive. Two high-outcome configurations combined high self-efficacy, engagement, and autonomy, whereas the joint absence of all five conditions characterized non-high participation. The findings extend digital-citizenship research from competence and compliance to participatory enactment and show how motivational resources may be translated through everyday academic engagement. The conclusions are associational and context-bounded because the study used cross-sectional self-reports and adapted measures.

Introduction

Universities now educate students in environments where learning, communication, public expression, and collective problem solving are intertwined with digital platforms. This development broadens the educational meaning of digital citizenship. Technical competence, online safety, information evaluation, and respectful conduct remain indispensable, but they do not fully capture whether students use digital media to make informed and constructive contributions. Participatory digital citizenship concerns this movement from responsible presence to purposeful action: helping others, sharing knowledge, addressing disagreement, and improving a school or community through digitally mediated practices (Choi, 2016; Choi & Cristol, 2021; Jones & Mitchell, 2016; Mossberger et al., 2007). For higher education, these practices matter because they connect disciplinary learning with agency, social responsibility, and students' capacity to contribute beyond the classroom (Blaj-Ward & Winter, 2019).

This question is especially salient in Asian higher education, where rapid platformization coexists with diverse institutional traditions and locally situated understandings of citizenship. Evidence from the Philippines links undergraduates' digital citizenship with global competence, while research in Hong Kong associates digital citizenship and online engagement with media and information literacy (Cleofas & Labayo, 2024; Wong et al., 2025). Chinese studies likewise show that digital participation and citizenship learning are shaped by curricular opportunities, institutional expectations, and student agency (Fu, 2024; Jiang, 2024; Lu et al., 2023). These settings caution against equating civic participation only with electoral or partisan activity. In university life, constructive online participation may be expressed through peer support, knowledge sharing, dispute resolution, and contributions to

school or community improvement. Examining these behaviors in China therefore offers a theoretically informative case for asking whether motivational resources developed in education are associated with participatory digital action under context-specific civic norms. It is not presented as a nationally representative or culturally universal test.

Digital-citizenship scholarship has generated rich accounts of competence, ethics, safety, critical literacy, and responsible behavior (Choi et al., 2017; Örtengren, 2024; Peart et al., 2024; Prasetyo et al., 2024). A smaller body of work has examined students' active contribution, but the motivational processes connecting university experiences to participation remain less developed. Motivational research focuses on psychological needs and efficacy beliefs, whereas student-engagement research explains learners' investment in academic activity. Treating these literatures separately leaves an important question unanswered: how might feeling volitional, effective, and connected become confidence, sustained learning activity, and ultimately constructive digital contribution? Addressing this question can explain why access and competence alone may not result in participation.

An integrated account can connect these domains without assuming that cross-sectional associations establish causal order. Self-determination theory proposes that satisfaction of autonomy, competence, and relatedness supports internalized motivation and adaptive functioning (Ryan & Deci, 2000; Vansteenkiste et al., 2020). Social cognitive theory explains how efficacy beliefs organize effort and action (Bandura, 1997, 2001), and student-engagement theory identifies the behavioral and cognitive investment through which motivational resources are enacted in educational settings (Fredricks et al., 2004; Kahu, 2013). Their integration suggests a motivational enactment process: need-supportive experience is associated with a stronger sense of capability, capability is associated with active investment in learning, and engagement provides opportunities to practice the communicative and collaborative behaviors that can be carried into online civic participation.

The study also distinguishes two forms of explanation. Composite-score path analysis estimates average net associations and theoretically ordered indirect relationships across the sample. It cannot determine whether different conjunctions of motivational resources accompany the same outcome or whether non-high participation follows a distinct pattern. fsQCA addresses those questions through set-theoretic sufficiency, equifinality, and asymmetry (Fiss, 2011; Pappas & Woodside, 2021; Ragin, 2008). Using the methods together is valuable only when their estimands remain distinct: the path model evaluates general covariation, whereas fsQCA identifies empirically sufficient combinations. Agreement can reveal recurrent resources; divergence can expose heterogeneity hidden by average associations.

Using survey data from 9,929 undergraduates nested within 49 academic-program recruitment groups in Shandong, China, the study estimates direct and indirect associations among psychological need satisfaction, academic self-efficacy, learning engagement, and online civic engagement. It then disaggregates need satisfaction into autonomy, competence, and relatedness to identify sufficient configurations for high and non-high participation. The study makes three contributions. First, it conceptualizes online civic engagement as participatory enactment within higher education, extending

digital citizenship beyond competence and compliance. Second, it specifies how need satisfaction, efficacy, and engagement may work as differentiated links between university experience and constructive contribution. Third, it uses the Chinese context to develop a bounded Asia-Pacific account of participation while distinguishing average associations from multiple sufficient pathways. All claims remain associational because the data are cross-sectional and self-reported.

Theoretical background and hypotheses

Online civic engagement as an educational digital-citizenship outcome

Digital citizenship encompasses the knowledge, skills, values, attitudes, and practices through which people participate in societies permeated by digital technologies. Early accounts emphasized access and responsible use; later work added critical, ethical, relational, and sociotechnical dimensions (Choi, 2016; Choi & Cristol, 2021; Harrison, 2022; Örtengren, 2024). In higher education, digital citizenship therefore extends beyond avoiding harm or demonstrating technical proficiency. It includes the capacity to evaluate information, communicate across difference, create knowledge, and contribute to collective purposes. Blaj-Ward and Winter (2019) similarly argue that students become digital citizens through participation in academic and professional communities, not simply through mastery of a checklist of digital skills.

The outcome examined here is online civic engagement, operationalized through behaviors such as using the internet to improve a school or community, learning how to help others, sharing skills or knowledge, and attempting to resolve online disputes. Jones and Mitchell (2016) distinguish these participatory behaviors from online respect, showing that responsible digital citizenship includes both interpersonal conduct and active contribution. This formulation is useful in the Chinese university context because it captures prosocial and community-oriented action without presuming that all civic behavior takes a partisan or electoral form. It also distinguishes online civic engagement from general screen time, technology acceptance, and private academic use.

Research across Asia-Pacific settings reinforces the importance of context. Philippine evidence connects youth digital citizenship with global competence; a Hong Kong study links digital citizenship and online engagement with media and information literacy; and Chinese studies show how curriculum, digital storytelling, and student agency shape civic learning (Cleofas & Labayo, 2024; Fu, 2024; Jiang, 2024; Wong et al., 2025). These studies establish that participation can be educationally meaningful, yet they do not fully explain the motivational pathway through which students move from supportive learning experiences to constructive digital action. The present study addresses that gap by treating online civic engagement as an outcome of motivational resources and everyday academic practices.

Higher education may cultivate such engagement when digitally mediated learning connects disciplinary knowledge with social contribution. Discussion, analysis, collaboration, interaction with instructors, and

sustained effort allow students to rehearse explanation, perspective taking, and problem solving. Participation also requires motivational resources: autonomy can make contribution feel self-endorsed, competence can support effectiveness, and relatedness can make contribution socially meaningful. Academic self-efficacy and learning engagement may then mobilize those resources. This focus differentiates the study from models that predict digital citizenship primarily from access, skills, or attitudes by locating participatory behavior within students' motivational and educational experience.

Psychological need satisfaction and academic self-efficacy

Self-determination theory identifies autonomy, competence, and relatedness as basic psychological needs whose satisfaction supports integrated motivation, persistence, and well-being (Ryan & Deci, 2000; Vansteenkiste et al., 2020). Autonomy satisfaction reflects a sense of volition and authentic self-expression. Competence satisfaction concerns feeling effective and capable. Relatedness satisfaction reflects feeling cared for and connected to others. Although analytically distinct, these needs jointly provide a motivational foundation for adaptive action.

Academic self-efficacy refers to students' beliefs that they can organize and execute actions required to meet academic demands (Bandura, 1997; Zimmerman, 2000). Need satisfaction should support such beliefs. Competence satisfaction provides direct experiential evidence of effectiveness; autonomy permits students to experience achievement as self-authored; and relatedness supplies encouragement and feedback that can reinforce perceived capability. When these needs are met, students are more likely to interpret academic challenges as manageable and to sustain confidence in their capacity to learn.

H1. Psychological need satisfaction is positively associated with academic self-efficacy.

Psychological need satisfaction and learning engagement

Learning engagement captures students' behavioral and cognitive investment in educational activities, including effort, analysis, interaction, participation, and use of learning resources (Fredricks et al., 2004; Kahu, 2013; Kuh, 2009). Need-supportive experiences can energize engagement by making learning feel volitional, achievable, and socially meaningful. Autonomy satisfaction supports ownership of learning, competence satisfaction encourages persistence, and relatedness satisfaction increases willingness to interact with peers and teachers.

The educational-interface perspective treats engagement as the mechanism through which personal and institutional factors influence outcomes (Kahu & Nelson, 2018). Psychological need satisfaction should therefore have a direct association with engagement, independent of its effect through self-efficacy. Students who feel free to express themselves, capable of acting, and connected to others are more likely to discuss academic work, analyze ideas, seek resources, and invest effort in course requirements.

H2. Psychological need satisfaction is positively associated with learning engagement.

Academic self-efficacy and learning engagement

Social cognitive theory proposes that efficacy beliefs influence task choice, effort, persistence, and resilience (Bandura, 1997, 2001). In university learning, students with stronger academic self-efficacy are more likely to approach difficult material, seek clarification, participate in discussion, and continue after setbacks. Recent educational-technology research likewise positions self-efficacy and engagement as connected mechanisms in technology-rich learning (Yilmaz & Birisci, 2026). These behaviors overlap with the behavioral and cognitive dimensions of engagement.

Self-efficacy also provides a mechanism through which need satisfaction can be translated into engagement. Feeling autonomous, competent, and related may strengthen perceived academic capability; perceived capability, in turn, makes sustained investment more likely. The present model therefore includes both a direct need-satisfaction pathway and an indirect pathway through academic self-efficacy.

H3. Academic self-efficacy is positively associated with learning engagement.

Motivational pathways to online civic engagement

Psychological need satisfaction may directly support online civic engagement. Autonomous students may perceive digital contribution as personally endorsed rather than externally imposed. Competence satisfaction can reduce the uncertainty associated with helping others or entering public discussion. Relatedness satisfaction can orient students toward reciprocal support and community improvement. These experiences should increase the likelihood that students use digital tools for prosocial and participatory purposes.

Academic self-efficacy should also support online civic engagement. Sharing knowledge or attempting to resolve a dispute requires confidence that one can understand problems, articulate ideas, and make a useful contribution. Students with stronger academic self-efficacy may be more willing to expose their ideas to evaluation and to enter digitally mediated problem-solving situations.

Learning engagement is expected to have the strongest proximal association with online civic engagement. Engaged students have greater exposure to knowledge, more practice in analysis and discussion, and more frequent interaction with peers and teachers. These resources can be transferred into online helping, knowledge sharing, conflict resolution, and community participation. Engagement thus provides the behavioral bridge from motivation to digital civic action.

H4. Psychological need satisfaction is positively associated with online civic engagement.

H5. Academic self-efficacy is positively associated with online civic engagement.

H6. Learning engagement is positively associated with online civic engagement.

Taken together, the preceding arguments imply multiple indirect pathways. Need satisfaction may influence online civic engagement through learning engagement, through academic self-efficacy, and through a serial sequence in which need satisfaction strengthens self-efficacy, self-efficacy increases engagement, and engagement supports online civic action. The serial pathway is especially important because it distinguishes perceived capability from its enactment in learning behavior.

H7. Psychological need satisfaction is positively associated with online civic engagement through the serial pathway of academic self-efficacy and learning engagement.

A configurational perspective

The path model estimates average net associations, whereas a configurational perspective allows the same outcome to be linked with multiple conjunctions of conditions. It recognizes conjunctural causation, equifinality, and causal asymmetry: a condition can operate differently depending on what accompanies it, different combinations can be sufficient for the same outcome, and the configuration associated with non-high online civic engagement need not be the inverse of a high-engagement configuration (Fiss, 2011; Ragin, 2008; Woodside, 2013). In this cross-sectional application, “sufficient” refers to set-theoretic empirical sufficiency, not temporal or experimental causation.

For the configurational analysis, psychological need satisfaction is disaggregated into autonomy, competence, and relatedness. This step allows the analysis to examine whether different needs can complement or compensate for one another in conjunction with academic self-efficacy and learning engagement. The analysis is guided by a research question rather than directional hypotheses because fsQCA is intended to discover sufficient combinations rather than estimate isolated effects.

RQ1. Which configurations of academic self-efficacy, learning engagement, autonomy satisfaction, competence satisfaction, and relatedness satisfaction are sufficient for high and non-high online civic engagement?

Figure 1 integrates the seven hypotheses by showing the proposed direct paths and the serial sequence from psychological need satisfaction to online civic engagement through academic self-efficacy and learning engagement.

The path analysis tests H1–H7, whereas fsQCA evaluates whether distinct condition combinations are sufficient for high and non-high online civic engagement.

Method

Participants and procedure

Data were collected in September 2025 from first- through fifth-year undergraduate students in Shandong Province, China, across humanities, sciences, engineering, and medicine. The institutional ethics committee approved the protocol before data collection. The study used purposive convenience sampling. Forty-nine instructors from distinct undergraduate program groups distributed the same survey to eligible students in their groups. Program groups—not institutions, colleges, or administrative departments—are the sampling clusters represented in the dataset; institutional or provincial representativeness is therefore not claimed. The survey was administered online through Wenjuanxing (Questionnaire Star). The landing page explained the study purpose, voluntary participation, anonymity, data use, and the right to stop before submission. Participants provided electronic informed consent before proceeding. Screening was applied to all submissions, and 9,929 responses (96.7%) met the prespecified completeness and survey-quality criteria and were retained. No personally identifying information was included in the analysis file. The retained students were nested within 49 undergraduate program recruitment groups, each coordinated by one participating instructor (mean retained cluster size = 202.6). Program group was used as the clustering unit for symmetric inference because students recruited through the same group could share instructional or recruitment contexts. The cluster definition should not be interpreted as a sample of 49 universities.

Measures

The questionnaire was administered in Chinese. Because the study used selected or adapted items rather than unmodified source instruments, construct labels refer to the item sets analyzed here. Complete item wording, response scales, scoring rules, and adaptation records are documented in the study codebook and are available from the corresponding author upon reasonable request.

Psychological need satisfaction

Psychological need satisfaction was assessed with six positively worded Chinese-language items selected and contextually adapted from the Basic Psychological Need Satisfaction and Frustration Scale (BPNSFS; Chen et al., 2015). Two items represented each need, covering choice and volition (autonomy), effectiveness in dealing with challenges (competence), and connection with caring others (relatedness). The adaptation preserves the source constructs but is not presented as the complete BPNSFS or as a validated short form. The six satisfaction items were averaged for the overall need-satisfaction score used in the path analysis. This theory-guided aggregation does not imply that the three needs are interchangeable; the two-item need scores were retained separately in fsQCA. Responses ranged from 1 (strongly disagree) to 7 (strongly agree). Three negatively worded candidate items represented need frustration and were not reverse-scored into the satisfaction composite (Vansteenkiste et al., 2020). The six-item composite had satisfactory internal consistency (Cronbach's $\alpha = .831$). Reliability of the two-item dimensions is reported in the fsQCA subsection.

Academic self-efficacy

Academic self-efficacy was assessed with a nine-item, study-specific Chinese-language item set informed by the self-efficacy-for-learning-and-performance domain of the Motivated Strategies for

Learning Questionnaire (MSLQ; Pintrich et al., 1991). Content concerned confidence in managing academic demands, persisting with difficult coursework, and completing learning tasks. One of ten candidate items used an incompatible response format and was excluded before composite scoring; the exclusion was based on response-format compatibility, not its association with the outcome. The remaining nine items used a common four-point scale and were averaged, with higher values indicating stronger self-efficacy. Because item wording and response options were adapted, the measure is not described as the unmodified MSLQ subscale. Internal consistency was excellent (Cronbach's $\alpha = .944$).

Learning engagement

Learning engagement was assessed with an eight-item, study-specific Chinese-language index informed by behavioral and cognitive engagement frameworks (Fredricks et al., 2004; Kahu, 2013) and practices represented in the National Survey of Student Engagement (National Survey of Student Engagement, 2025). Items addressed discussion of assignments, use of online media for coursework, analysis of ideas, use of learning spaces, attendance, effort, and communication with instructors. The breadth of behaviors was intended to capture investment in learning rather than platform use alone. Responses used a five-point scale and were averaged. This adapted index is not a complete NSSE engagement indicator. It demonstrated high internal consistency (Cronbach's $\alpha = .919$).

Online civic engagement

Online civic engagement was assessed with four Chinese-language items adapted from the participatory dimension of youth digital citizenship developed by Jones and Mitchell (2016). Items asked whether students had used the internet to improve their school or community, learn how to help others, resolve disputes or conflicts, and share skills or knowledge. The measure captures constructive participation rather than general internet use, political ideology, or online respect. Because the source instrument was developed with youth, its use with Chinese undergraduates is treated as a contextual adaptation and not as evidence of full cross-cultural equivalence. Responses ranged from 1 (strongly disagree) to 7 (strongly agree) and were averaged. Internal consistency was satisfactory (Cronbach's $\alpha = .878$).

Control variables

Gender, grade, disciplinary field, and urban–rural background were dummy coded and included as adjustment variables because demographic and educational contexts may be related to digital participation. The hypotheses and interpretation concern the focal motivational coefficients; control estimates were not used to support substantive claims.

Composite-score path analysis

The symmetric component used a two-stage composite-score path analysis implemented in a scripted R workflow. Item-set measurement quality was evaluated first; retained items were then averaged within construct and the composites standardized. Each endogenous composite was estimated in a separate linear equation containing its theoretically preceding constructs and the demographic controls. The covariance estimator was clustered by the 49 academic-program recruitment groups. The path stage

used observed composite scores and did not jointly estimate a latent-variable model. Variable-construction rules, diagnostic calculations, software versions, and package versions are recorded in the analysis syntax available from the corresponding author upon reasonable request.

Before composite scoring, the four retained item sets were evaluated at the item level using standardized indicator loadings, Cronbach's α , composite reliability (CR), average variance extracted (AVE), and heterotrait-monotrait ratios (HTMT). Values above .70 for reliability, above .50 for AVE, and below .85 for HTMT served as guidelines rather than mechanical decision rules (Fornell & Larcker, 1981; Hair et al., 2022; Henseler et al., 2015). These diagnostics evaluate the adapted item sets but do not convert the subsequent composite-score path analysis into latent structural equation modeling. Full-collinearity variance inflation factors were below 3.3 (Kock, 2015), and Harman's first factor accounted for 45.5% of item variance (Podsakoff et al., 2003). Neither diagnostic rules out common-method bias.

Path-model reporting included standardized coefficients, cluster-robust confidence intervals, R^2 , f^2 , and ten-fold out-of-sample Q^2 values. Each equation was fitted on nine folds and used to predict the held-out records. Q^2 was calculated as one minus the prediction-error sum of squares divided by the outcome sum of squares, with positive values indicating internal predictive relevance (Stone, 1974). The cross-validation is a case-level internal sample check, not group-level or external validation. Indirect associations were evaluated in 1,000 cluster-bootstrap samples by resampling the 49 program groups with replacement and recomputing coefficient products. A percentile interval excluding zero was treated as evidence of an indirect association. All estimates are interpreted as associational because the survey was cross-sectional.

fsQCA analysis

fsQCA examined how academic self-efficacy, learning engagement, autonomy satisfaction, competence satisfaction, and relatedness satisfaction combined in relation to high online civic engagement. The overall need-satisfaction composite was disaggregated because the method evaluates theoretically distinct conditions in conjunction. The two-item autonomy and competence scores had α values of .743 and .804. The two-item relatedness score had $\alpha = .528$ and an inter-item correlation of .360.

Configurations involving relatedness are consequently interpreted with caution and were checked in an analysis that excluded this condition.

Raw scores were calibrated into fuzzy-set memberships using the direct method (Pappas & Woodside, 2021; Ragin, 2008). The 95th, 50th, and 5th percentiles served as full-membership, crossover, and full-nonmembership anchors. Membership scores exactly equal to .50 were increased to .501 to avoid ambiguous truth-table assignment. Necessity was assessed before sufficiency, with .90 used as the conventional consistency benchmark.

A truth table was created for the five conditions. Given the large sample, the main analysis used a frequency threshold of 100 cases, sufficiency consistency of .80, and a proportional reduction in inconsistency (PRI) threshold of .65 (Pappas & Woodside, 2021). The manuscript interprets conservative

solutions based only on observed truth-table rows, limiting dependence on logical remainders. Raw coverage, unique coverage, and consistency are reported for each configuration, together with overall solution consistency and coverage. Because only conservative solutions are interpreted, no formal core/peripheral distinction is inferred. Non-high online civic engagement was analyzed separately. Robustness checks varied frequency and consistency thresholds, excluded the lower-reliability relatedness condition, and used a 70/30 training-test split as an internal predictive check.

Results

Sample characteristics

Table 1 presents the demographic and academic composition of the analytic sample across gender, grade, disciplinary field, and urban–rural background.

Table 1 Sample characteristics			
Variable	Category	n	%
Gender	Male	5,072	51.1
Gender	Female	4,857	48.9
Grade	First-year undergraduate	4,140	41.7
Grade	Second-year undergraduate	896	9.0
Grade	Third-year undergraduate	1,587	16.0
Grade	Fourth-year undergraduate	3,199	32.2
Grade	Fifth-year undergraduate	107	1.1
Disciplinary field	Humanities	3,861	38.9
Disciplinary field	Sciences	2,325	23.4
Disciplinary field	Engineering	2,959	29.8
Disciplinary field	Medicine	784	7.9
Urban-rural background	Urban	3,623	36.5
Urban-rural background	Rural	6,306	63.5
Note. N = 9,929.			

The sample was nearly gender-balanced; first- and fourth-year students together accounted for 73.9% of participants, humanities and engineering were the largest disciplinary groups, and 63.5% reported a rural background. These distributions characterize the analytic sample and should not be interpreted as nationally representative.

Descriptive statistics and measurement quality

Table 2 reports the descriptive statistics, reliability coefficients, and bivariate correlations for the focal constructs. All constructs showed satisfactory reliability and positive correlations. Learning engagement had the strongest bivariate association with online civic engagement ($r = .606$), followed by academic self-efficacy ($r = .518$) and psychological need satisfaction ($r = .482$).

Table 2
Descriptive statistics, reliabilities, and correlations

No.	Construct	M	SD	α	1	2	3	4
1	Psychological need satisfaction	4.780	1.233	0.831	—			
2	Academic self-efficacy	2.951	0.699	0.944	.532	—		
3	Learning engagement	3.642	0.876	0.919	.627	.608	—	
4	Online civic engagement	5.457	1.381	0.878	.482	.518	.606	—
<i>Note. N = 9,929. All correlations are significant at $p < .001$ due to the large sample; interpretation focuses on effect magnitude.</i>								

Across the four focal item sets, indicator loadings ranged from .634 to .896, CR from .876 to .953, and AVE from .542 to .733. HTMT ratios ranged from .569 to .729, below the .85 guideline. Together with the α coefficients in Table 2, these diagnostics supported use of the composite scores for the planned analysis. They do not establish measurement invariance or full cross-cultural validation of the adapted measures.

Composite-score path results and hypothesis testing

The path equations accounted for 29.5% of the variance in academic self-efficacy, 50.4% of the variance in learning engagement, and 41.4% of the variance in online civic engagement. Ten-fold Q^2 values were .293, .503, and .412, respectively. All were positive, supporting internal predictive relevance within the observed sample; they should not be read as external validation. The standardized path estimates and hypothesis tests are reported in Table 3.

Table 3
Path estimates and hypothesis tests

Hyp.	Path	β	SE	95% CI	p	f ²
H1	Psychological need satisfaction → Academic self-efficacy	.531	.013	[.505, .557]	< .001	.395
H2	Psychological need satisfaction → Learning engagement	.429	.009	[.412, .446]	< .001	.263
H3	Academic self-efficacy → Learning engagement	.377	.013	[.353, .402]	< .001	.202
H4	Psychological need satisfaction → Online civic engagement	.120	.013	[.095, .146]	< .001	.014
H5	Academic self-efficacy → Online civic engagement	.210	.013	[.184, .237]	< .001	.044
H6	Learning engagement → Online civic engagement	.399	.016	[.368, .430]	< .001	.135
<i>Note. Standardized coefficients with standard errors clustered by academic-program recruitment group (49 clusters). Demographic controls were included in each applicable equation but are omitted here because the hypotheses concern the focal paths.</i>						

Psychological need satisfaction was positively associated with academic self-efficacy ($\beta = .531$, $p < .001$), supporting H1. It was also positively associated with learning engagement ($\beta = .429$, $p < .001$), supporting H2. Academic self-efficacy had an additional positive association with learning engagement ($\beta = .377$, $p < .001$), supporting H3.

Psychological need satisfaction ($\beta = .120$, $p < .001$), academic self-efficacy ($\beta = .210$, $p < .001$), and learning engagement ($\beta = .399$, $p < .001$) were all positively associated with online civic engagement, supporting H4–H6. Learning engagement had the largest direct coefficient and the largest f^2 value in the outcome equation, although its effect size remained in the small-to-moderate range.

Indirect associations

The prespecified serial indirect association from psychological need satisfaction through academic self-efficacy and learning engagement to online civic engagement was .079, 95% CI [.072, .087], supporting H7. Other specific indirect associations were .112 for need satisfaction → self-efficacy → online civic engagement, .172 for need satisfaction → learning engagement → online civic engagement, .199 for need satisfaction → self-efficacy → learning engagement, and .149 for self-efficacy → learning engagement → online civic engagement; all cluster-bootstrap intervals excluded zero. The three need-satisfaction indirect products summed to approximately .363, and the direct-plus-indirect association to approximately .483. These totals are descriptive because they use rounded coefficients. Calibration anchors are reported in Table 4.

fsQCA necessity analysis and calibration

Table 4 reports the direct-calibration anchors used to transform the raw scores for the five causal conditions and the online civic engagement outcome into fuzzy-set memberships.

Table 4
Calibration anchors

Set	Full nonmembership	Crossover	Full membership
ASE	1.889	3.000	4.000
ENG	2.250	3.625	5.000
AUT	2.500	5.000	7.000
COMP	1.500	4.500	7.000
REL	3.000	5.000	7.000
OCE	3.000	5.500	7.000
<i>Note. ASE = academic self-efficacy; ENG = learning engagement; AUT = autonomy satisfaction; COMP = competence satisfaction; REL = relatedness satisfaction; OCE = online civic engagement.</i>			

Consistency was .766 for learning engagement, .730 for academic self-efficacy, .726 for autonomy satisfaction, .726 for competence satisfaction, and .696 for relatedness satisfaction. Consistency for the five negated conditions ranged from .506 to .557. Because all values were well below .90, no single condition was interpreted as necessary and the analysis proceeded to conjunctions.

Sufficient configurations for high and non-high online civic engagement

The conservative sufficiency analysis yielded two configurations for high online civic engagement and one for non-high engagement, as summarized in Table 5.

Table 5
Configurations for high and non-high online civic engagement

Solution	ASE	ENG	AUT	COMP	REL	Consistency	Raw cov.	Unique cov.
High OCE 1 Relationally supported agency	●	●	●	—	●	.935	.497	.234
High OCE 2 Autonomy–engagement under non-high competence	●	●	●	⊗	—	.930	.319	.055
Non-high OCE Generalized resource deficit	⊗	⊗	⊗	⊗	⊗	.864	.545	.545
<i>Note.</i> ● = presence; ⊗ = absence; — = irrelevant condition. Main high-outcome solution consistency = .929; solution coverage = .553. Non-high outcome solution consistency = .864; coverage = .545.								

Two sufficient pathways produced high online civic engagement. The first, labeled relationally supported agency, combined high academic self-efficacy, high learning engagement, high autonomy satisfaction, and high relatedness satisfaction; competence satisfaction was irrelevant. This pathway had a consistency of .935 and raw coverage of .497. It indicates that confident and actively engaged students can translate autonomy and social connection into digital civic contribution even when competence satisfaction varies.

The second pathway, labeled autonomy-engagement under non-high competence, combined high academic self-efficacy, high learning engagement, high autonomy satisfaction, and non-high competence satisfaction; relatedness was irrelevant. Its consistency was .930 and its raw coverage was .319. This configuration does not imply that lower competence satisfaction improves online civic engagement. Rather, it indicates that high competence satisfaction was not required within this sufficient combination when self-efficacy, engagement, and autonomy were all high.

High academic self-efficacy, high learning engagement, and high autonomy satisfaction formed a recurrent conjunction across the two conservative high-outcome solutions. This pattern converges with the path analysis on the relevance of capability beliefs and engagement while adding autonomy as a recurring enabling condition. It is described as a recurrent conjunction—not a formal fsQCA core—because core/peripheral status requires comparison across parsimonious and intermediate solutions.

The analysis of non-high online civic engagement produced a different configuration: the simultaneous absence of high academic self-efficacy, learning engagement, autonomy satisfaction, competence satisfaction, and relatedness satisfaction. The configuration had consistency of .864 and coverage of

.545. This negative solution was not the simple inverse of either high-outcome pathway, illustrating configurational asymmetry.

Robustness and predictive validity

The high-outcome solution was unchanged when the frequency threshold varied from 50 to 150 or when the consistency threshold increased to .82; solution consistency and coverage remained .929 and .553. In the 70% training sample, the retained solution family had consistency of .911 and coverage of .572; applying it to the 30% test sample produced coverage of .580 and the same substantive solution family. This split-sample result is an internal predictive check rather than external replication. When relatedness was excluded, the solution reduced to the recurrent conjunction of high academic self-efficacy, high learning engagement, and high autonomy satisfaction. The principal configurational conclusion therefore did not depend on the lower-reliability relatedness condition.

Discussion

Main findings

This study examined how motivational resources and learning engagement were associated with participatory action in digital environments among Chinese undergraduates. Need satisfaction was positively associated with academic self-efficacy and learning engagement; self-efficacy was additionally associated with engagement; and all three constructs were positively associated with online civic engagement. The positive serial indirect association was consistent with the proposed ordering from need-supportive experience to perceived capability, active learning, and digital contribution. The result is theoretically coherent, but it is not evidence that the sequence unfolded over time. Reverse and reciprocal relationships remain plausible, particularly because constructive contribution may itself strengthen efficacy, connection, and engagement.

Learning engagement showed the strongest proximal association with online civic engagement ($\beta = .399$). This finding is substantively important because it locates participatory digital citizenship within the ordinary work of higher education. Students who discuss academic work, analyze ideas, seek resources, invest effort, and interact with instructors repeatedly practice explaining, evaluating, collaborating, and responding to others. Those practices may provide a behavioral bridge between motivational resources and online helping, knowledge sharing, dispute resolution, and community contribution. Digital citizenship education can therefore be embedded in disciplinary learning rather than confined to one-off instruction about platforms, safety, or etiquette.

The configurational findings refined the average associations. No individual condition met the necessity threshold, and two configurations were sufficient for high online civic engagement. High self-efficacy, engagement, and autonomy formed a recurrent conjunction; relatedness characterized one pathway, while high competence satisfaction was not required in the other. The joint absence of all five conditions characterized non-high participation. The sensitivity analysis excluding relatedness retained the

recurrent three-condition conjunction, so the principal configurational interpretation does not depend on the lower-reliability relatedness measure. These patterns indicate empirical equifinality and asymmetry; they do not establish causal recipes or immutable student types.

Theoretical contributions

First, the study advances digital-citizenship scholarship by conceptualizing online civic engagement as participatory enactment. Much existing work appropriately emphasizes competence, safety, ethics, and respectful conduct. The present model asks a subsequent educational question: when do students use digital capacity to contribute? By focusing on helping, knowledge sharing, conflict resolution, and school or community improvement, the study links digital citizenship with practices through which higher education can cultivate agency and social responsibility (Blaj-Ward & Winter, 2019; Choi & Cristol, 2021). This formulation does not diminish protective or competence-based approaches; it specifies the participatory outcome those foundations may enable.

Second, the study develops a motivational enactment account by integrating self-determination, social cognitive, and student-engagement perspectives. Need satisfaction describes the quality of students' psychological experience, academic self-efficacy reflects perceived capability, and engagement captures the investment through which motivational resources are expressed in learning. The serial indirect association gives empirical form to a theoretically ordered sequence from need-supportive experience to confidence, active learning, and digital contribution. Its value is explanatory rather than causal: the sequence identifies an integrative mechanism that longitudinal and intervention research can test. It also explains why technical access or generalized competence may be insufficient when students lack volition, confidence, or opportunities to engage.

Third, the Chinese setting provides a context-bounded contribution to Asia-Pacific higher education. Regional studies show that digital participation is shaped by educational opportunities, media literacy, institutional expectations, and locally meaningful forms of agency (Cleofas & Labayo, 2024; Fu, 2024; Jiang, 2024; Wong et al., 2025). The current findings suggest that constructive, prosocial participation can be analyzed through motivational resources cultivated in university learning even where citizenship is not primarily expressed through electoral activity. At the same time, the one-province convenience sample prevents claims that the pathways characterize China as a whole. The theoretical payoff lies in showing how a general motivational vocabulary can be connected to locally meaningful participatory practices without treating context as a mere sampling label.

Fourth, the study clarifies what is gained—and what is not gained—by combining symmetric and configurational analyses. The path model estimates general net associations and an ordered indirect relationship; fsQCA identifies sufficient conjunctions, equifinality, and asymmetry. Convergence around self-efficacy and engagement indicates that capability beliefs and active learning recur across analytical lenses. Divergence across the need dimensions shows that uniformly high need satisfaction was not required in every high-outcome pathway. This is more informative than presenting fsQCA as a

robustness test for the path model because the two analyses answer different questions. Neither method removes measurement error, sampling limitations, or the absence of temporal evidence.

Implications for higher education policy and practice

For higher education policy, the results support broadening digital-citizenship strategies from infrastructure, security, and compliance toward opportunities for constructive participation. Universities can integrate digital civic practice into general education and disciplinary courses through peer-support resources, public-facing explanations of knowledge, moderated deliberation, digital service learning, and community problem-solving projects. These activities make contribution observable and assessable while connecting academic learning with social responsibility. In Asian settings, institutions should adapt the form and public reach of such activities to local civic norms rather than importing a single model of participation.

Autonomy-supportive design appears especially relevant because autonomy recurred in both high-outcome configurations. Instructors can offer meaningful choices in topics, digital formats, audiences, and modes of contribution while explaining the social purpose of the work. Autonomy support is compatible with structure: clear goals, credible-source standards, ethical boundaries, accessibility requirements, and formative guidance can help students exercise voice responsibly. Such design allows participation to feel self-endorsed without making public exposure compulsory or ignoring risks associated with online visibility.

Mastery-building experiences can strengthen self-efficacy for digital contribution. Scaffolded tasks, modeling, low-stakes practice, formative feedback, and revision can help students develop confidence before contributing in public or community-facing settings. The configuration containing non-high competence satisfaction should not be interpreted as evidence that lower competence is beneficial. It indicates only that high general competence satisfaction was not required when self-efficacy, engagement, and autonomy were jointly high. Support should therefore focus on concrete experiences of capability rather than labeling students by a single disposition.

Learning engagement should also be connected explicitly to socially meaningful uses of knowledge. Assignments can ask students to create accessible resources, explain evidence to non-specialist audiences, offer peer support, or develop digital products with community partners. Stable teams, peer recognition, mentoring, and constructive discussion norms can make contribution relationally meaningful. Because relatedness reliability was limited in this study, relational interventions should be evaluated directly rather than justified solely by the first fsQCA configuration.

At the institutional level, the configurational results favor a portfolio of entry points. Some students may benefit from stronger relational support, while others may participate when autonomy, efficacy, and active engagement align. Programs can use voluntary student feedback and authentic performance tasks to improve opportunities, but the configurations should not be used as diagnostic profiles or risk

scores for individuals. Evaluation should assess not only participation frequency but also informational quality, reciprocity, accessibility, and whether activities create benefit without exposing students to avoidable digital harms.

Limitations and future research

The cross-sectional design is the principal limitation. Although the model follows a theoretically ordered sequence, temporal precedence was not observed, and online civic engagement could reinforce efficacy, engagement, or relatedness. The large sample yields precise estimates but cannot compensate for the lack of temporal leverage. Longitudinal, cross-lagged, and intervention studies are required before causal claims can be made. Experiments could test whether autonomy-supportive course design, mastery-oriented feedback, or digital service-learning activities change later participation.

All focal measures were collected in the same self-report survey, creating common-method and social-desirability risks. Full-collinearity and single-factor diagnostics were acceptable but cannot remove those risks. Future research should combine surveys with digital trace data, peer or instructor reports, observed knowledge sharing, conflict-resolution records, and externally evaluated civic projects. Such evidence would better capture the quality and educational value of participation.

The need-satisfaction measure was abbreviated, and the two-item relatedness condition had limited reliability. The sensitivity analysis reduced reliance on relatedness, but the configuration containing it remains provisional. Future studies should use full validated measures of need satisfaction and frustration and examine the three needs separately as well as jointly. The recurrent autonomy–efficacy–engagement conjunction is the more defensible configurational conclusion in the present data.

Academic self-efficacy and learning engagement were measured with study-specific adapted item sets, and the online civic-engagement items were adapted from a youth instrument for Chinese undergraduates. Reliability and item-set diagnostics support their use within this sample, but they do not establish equivalence to the original MSLQ, NSSE, or youth digital-citizenship measures, nor do they establish cross-cultural validity. Future work should publish complete item wording and translation records, use cognitive interviewing, and test invariance across programs, demographic groups, institutions, languages, and national contexts.

The purposive convenience sample and recruitment through 49 academic-program groups limit generalizability. The cluster variable captures a shared recruitment context, not a representative multistage sample of institutions, and some demographic fields required harmonization across recruitment files even though the focal scales were consistent. Replication should use probability-based or multi-institutional sampling, a single documented data schema, and enough higher-level units to estimate between-context variation directly.

Finally, observed composite scores leave measurement error outside the path stage. The positive Q^2 values indicate internal predictive relevance relative to a mean benchmark, and the 70/30 fsQCA split

checks solution stability within the same sampling frame. Neither provides external prediction. fsQCA solutions also depend on calibration anchors and truth-table thresholds; conservative solutions reduce reliance on logical remainders but do not establish a formal core/peripheral structure. Future research should compare preregistered calibrations, longitudinal latent-variable models, and out-of-sample configurational replication while examining platform affordances, institutional culture, digital inequality (Senkbeil, 2026), and civic norms.

Conclusion

Participatory digital citizenship in higher education was positively associated with psychological need satisfaction, academic self-efficacy, and learning engagement among Chinese undergraduates. Engagement showed the largest direct association with online civic engagement, while the serial indirect association linked need satisfaction with self-efficacy, engagement, and constructive digital participation. The findings therefore position digital citizenship within the motivational and learning processes of university education and extend the concept from responsible use to participatory enactment.

The configurational analysis identified more than one sufficient route to high participation. High self-efficacy, engagement, and autonomy formed a recurrent conjunction, whereas the joint absence of all five conditions characterized non-high engagement. For universities, the results support autonomy-supportive pedagogy, mastery-building experiences, sustained academic engagement, and locally meaningful opportunities for digital contribution. The evidence remains associational and context-bounded; longitudinal, multi-institutional, and cross-national research is needed to determine whether these educational conditions produce durable changes in participatory digital citizenship.

Declarations

Ethics approval and informed consent

The study was approved by the authors' institutional ethics committee before data collection. Participants received information about the study, voluntary participation, anonymity, data use, and withdrawal before submission, and all participants provided electronic informed consent before beginning the survey.

Competing interests

The authors declare that they have no competing interests.

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Author Contribution

W.Z. conceived the study, developed the theoretical framework and methodology, conducted the formal analyses, and wrote the original draft. Y.Z. and T.Y. coordinated the investigation and contributed to data collection and data curation. Z.L. contributed to methodology, validation, visualization, and interpretation of the results. X.L. contributed to supervision, interpretation of the findings, and critical revision of the manuscript. All authors participated in reviewing and editing the manuscript, read and approved the final version, and agree to be accountable for the work.

Data Availability

The de-identified data supporting the findings of this study are available from the corresponding author upon reasonable request. Access is subject to applicable ethical and institutional requirements.

References

1. Bandura, A. (1997). *Self-efficacy: The exercise of control*. W. H. Freeman.
2. Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual Review of Psychology*, 52, 1–26. <https://doi.org/10.1146/annurev.psych.52.1.1>
3. Blaj-Ward, L., & Winter, K. (2019). Engaging students as digital citizens. *Higher Education Research & Development*, 38(5), 879–892. <https://doi.org/10.1080/07294360.2019.1607829>
4. Chen, B., Vansteenkiste, M., Beyers, W., Boone, L., Deci, E. L., Van der Kaap-Deeder, J., Duriez, B., Lens, W., Matos, L., Mouratidis, A., Ryan, R. M., Sheldon, K. M., Soenens, B., Van Petegem, S., & Verstuyf, J. (2015). Basic psychological need satisfaction, need frustration, and need strength across four cultures. *Motivation and Emotion*, 39, 216–236. <https://doi.org/10.1007/s11031-014-9450-1>
5. Choi, M. (2016). A concept analysis of digital citizenship for democratic citizenship education in the internet age. *Theory & Research in Social Education*, 44(4), 565–607. <https://doi.org/10.1080/00933104.2016.1210549>
6. Choi, M., & Cristol, D. (2021). Digital citizenship with intersectionality lens: Towards participatory democracy driven digital citizenship education. *Theory Into Practice*, 60(4), 361–370. <https://doi.org/10.1080/00405841.2021.1987094>
7. Choi, M., Glassman, M., & Cristol, D. (2017). What it means to be a citizen in the internet age: Development of a reliable and valid digital citizenship scale. *Computers & Education*, 107, 100–112. <https://doi.org/10.1016/j.compedu.2017.01.002>
8. Cleofas, J. V., & Labayo, C. C. (2024). Youth netizens as global citizens: Digital citizenship and global competence among undergraduate students. *Frontiers in Communication*, 9, 1398001. <https://doi.org/10.3389/fcomm.2024.1398001>

9. Fiss, P. C. (2011). Building better causal theories: A fuzzy set approach to typologies in organization research. *Academy of Management Journal*, 54(2), 393–420.
<https://doi.org/10.5465/amj.2011.60263120>
10. Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18(1), 39–50.
<https://doi.org/10.2307/3151312>
11. Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research*, 74(1), 59–109.
<https://doi.org/10.3102/00346543074001059>
12. Fu, T. (2024). Digital storytelling for global citizenship education: A Chinese case study. *Asia Pacific Journal of Education*, 44(4), 873–886. <https://doi.org/10.1080/02188791.2022.2106187>
13. Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2022). *A primer on partial least squares structural equation modeling (PLS-SEM)* (3rd ed.). Sage.
14. Harrison, T. (2022). (In)civility and adolescents' moral decision making online: Drawing on moral theory to advance digital citizenship education. *Education and Information Technologies*, 27, 3277–3297. <https://doi.org/10.1007/s10639-021-10710-0>
15. Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, 43, 115–135. <https://doi.org/10.1007/s11747-014-0403-8>
16. Jiang, J. (2024). Agentic citizenship learning in China: Official curriculum and student agency. *Asia Pacific Education Review*, 25, 243–254. <https://doi.org/10.1007/s12564-024-09939-4>
17. Jones, L. M., & Mitchell, K. J. (2016). Defining and measuring youth digital citizenship. *New Media & Society*, 18(9), 2063–2079. <https://doi.org/10.1177/1461444815577797>
18. Kahu, E. R. (2013). Framing student engagement in higher education. *Studies in Higher Education*, 38(5), 758–773. <https://doi.org/10.1080/03075079.2011.598505>
19. Kahu, E. R., & Nelson, K. (2018). Student engagement in the educational interface: Understanding the mechanisms of student success. *Higher Education Research & Development*, 37(1), 58–71.
<https://doi.org/10.1080/07294360.2017.1344197>
20. Kock, N. (2015). Common method bias in PLS-SEM: A full collinearity assessment approach. *International Journal of e-Collaboration*, 11(4), 1–10. <https://doi.org/10.4018/ijec.2015100101>
21. Kuh, G. D. (2009). What student affairs professionals need to know about student engagement. *Journal of College Student Development*, 50(6), 683–706. <https://doi.org/10.1353/csd.0.0099>
22. Lu, H., Fu, K., Liu, X., & Hu, W. (2023). Digital citizen participation of college students: Reality and optimization path. *Problems of Education in the 21st Century*, 81(2), 244–257.
<https://doi.org/10.33225/pec/23.81.244>
23. Mossberger, K., Tolbert, C. J., & McNeal, R. S. (2007). *Digital citizenship: The internet, society, and participation*. MIT Press.

24. National Survey of Student Engagement (2025). NSSE 2025 U.S. English survey instrument. Indiana University. <https://nsse.indiana.edu/nsse/survey-instruments/us-english.html>
25. Örtengren, A. (2024). Philosophical underpinnings of digital citizenship through a postdigital lens: Implications for teacher educators' professional digital competence. *Education and Information Technologies*, 29, 9235–9258. <https://doi.org/10.1007/s10639-023-11965-5>
26. Pappas, I. O., & Woodside, A. G. (2021). Fuzzy-set qualitative comparative analysis (fsQCA): Guidelines for research practice in information systems and marketing. *International Journal of Information Management*, 58, 102310. <https://doi.org/10.1016/j.ijinfomgt.2021.102310>
27. Peart, M., Higgins, S., Gutiérrez-Esteban, P., Cubo Delgado, S., & Education (2024). *Citizenship and Social Justice*, 19(3), 463–475. <https://doi.org/10.1177/17461979231170232>.
28. Pintrich, P. R., Smith, D. A. F., Garcia, T., & McKeachie, W. J. (1991). *A manual for the use of the Motivated Strategies for Learning Questionnaire (MSLQ)*. University of Michigan.
29. Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, 88(5), 879–903. <https://doi.org/10.1037/0021-9010.88.5.879>
30. Prasetyo, W. H., Sari, B. I., Mahadir Naidu, N. B., & Nurlaili, N. G. (2024). Students' digital citizenship in ubiquitous technology: A comprehensive model based on DC-REP framework, internet attitudes, computer self-efficacy, and internet skills. *Education and Information Technologies*, 29, 23185–23224. <https://doi.org/10.1007/s10639-024-12761-5>
31. Ragin, C. C. (2008). *Redesigning social inquiry: Fuzzy sets and beyond*. University of Chicago Press.
32. Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55(1), 68–78. <https://doi.org/10.1037/0003-066X.55.1.68>
33. Senkbeil, M. (2026). Explaining social disparities in ICT literacy: The role of multiple socioeconomic status indicators and ICT-related motivations. *Education and Information Technologies*, 31, 2069–2098. <https://doi.org/10.1007/s10639-026-13900-w>
34. Stone, M. (1974). Cross-validatory choice and assessment of statistical predictions. *Journal of the Royal Statistical Society: Series B (Methodological)*, 36(2), 111–133. <https://doi.org/10.1111/j.2517-6161.1974.tb00994.x>
35. Vansteenkiste, M., Ryan, R. M., & Soenens, B. (2020). Basic psychological need theory: Advancements, critical themes, and future directions. *Motivation and Emotion*, 44, 1–31. <https://doi.org/10.1007/s11031-019-09818-1>
36. Wong, K. L. L., Chiu, M. M., Chan, K. K., Chong, K. M. E., Bhowmik, M., & Krzywosz-Rynkiewicz, B. (2025). Media and information literacy's antecedents and consequences: A survey of Hong Kong university students. *Information Development*. Advance online publication. <https://doi.org/10.1177/02666669251359962>
37. Woodside, A. G. (2013). Moving beyond multiple regression analysis to algorithms: Calling for adoption of a paradigm shift from symmetric to asymmetric thinking in data analysis and crafting

theory. *Journal of Business Research*, 66(4), 463–472. <https://doi.org/10.1016/j.jbusres.2012.12.021>

38. Yilmaz, N., & Birisci, S. (2026). A path model to infer K-8 students computer programming performance: The relation between classroom goal structure, self-efficacy, and classroom engagement. *Education and Information Technologies*, 31, 2027–2068. <https://doi.org/10.1007/s10639-025-13825-w>

39. Zimmerman, B. J. (2000). Self-efficacy: An essential motive to learn. *Contemporary Educational Psychology*, 25(1), 82–91. <https://doi.org/10.1006/ceps.1999.1016>

Figures

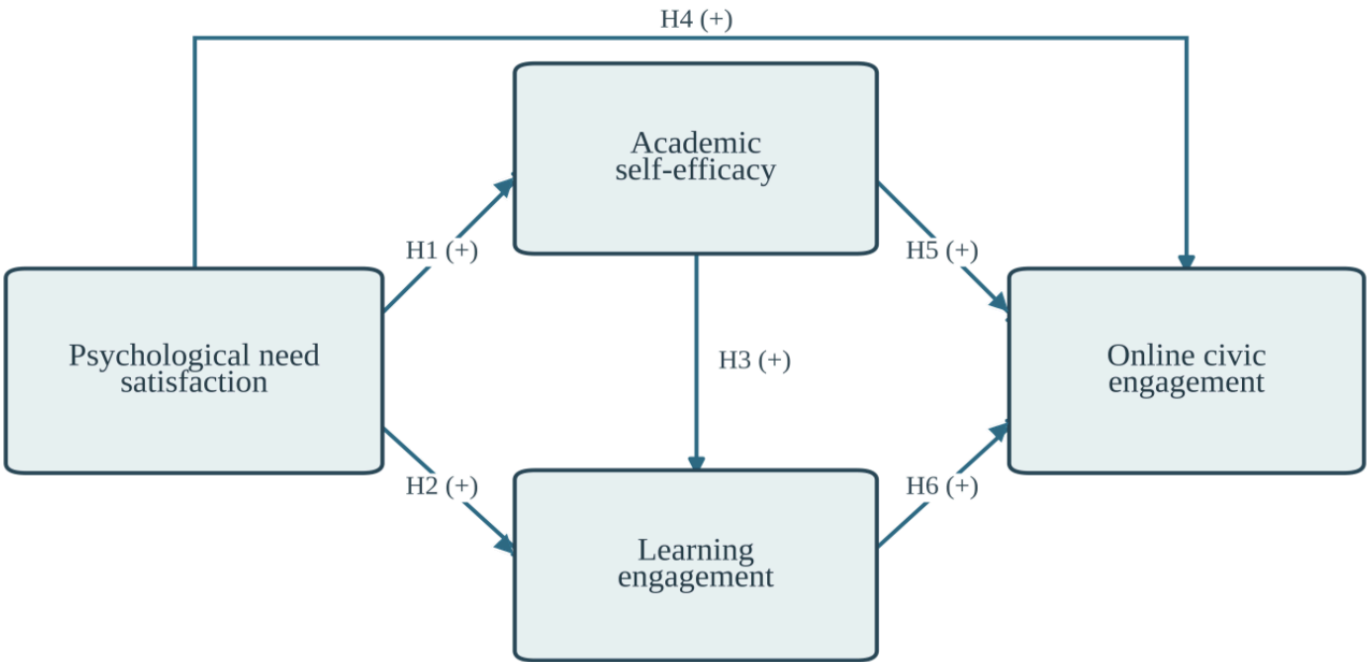


Figure 1

Conceptual model. H7 denotes the serial indirect association represented by H1, H3, and H6; demographic controls are omitted for clarity