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The cyber study companion phenomenon: mediated companionship and perceived learning experiences in study with me viewing

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The "study with me" (SWM) videos could be an indicator of companionship while studying alone. In this study, the linkages between SWM videos use, light connection presence, parasocial experience, perceived loneliness alleviation related to learning-related loneliness, learning motivation, and learning persistence were examined using a survey of 244 experienced viewers. The organization of hypotheses was motivated by the conceptual framework informed by the literature but it is neither a systematically derived nor a process theory. PLS-SEM was used as the principal methodology of hypothesisoriented linkage analysis. Directional analysis by DirectLiNGAM, RCD, nonrecursive SEM, machine learning, and fsQCA was used for exploratory analyses of the same data set but not as validation of the findings. Linkage uncertainty still holds for CP-PSI and LONMOT, and fsQCA analysis depends on calibration. The parasocial scale contains both perceived interaction and accumulated familiarity, and the light connection measure consists of two items but both scales suffer from high validity problems. The findings describe the associations between perceived learning experiences, without proving loneliness reduction, relationship formation, causal mechanisms, or video effectiveness.

KEYWORDS
learning motivation, mediated co-presence, parasocial experience, perceived learning loneliness alleviation, self-reported learning persistence, study with me videos

Introduction

Due to the proliferation of online learning, education seems to move to an individualized, visual mode of learning. This provides convenience and resources, but decreases social support, causing learners to experience increased psychological distance, isolation, and loneliness. Studies about "transactional distance" have pointed out that distance learning includes not only physical distance but also psychological and communicative distances between learners and instructors (Moore, 1993), and the quality of online learning is influenced by social, cognitive, and teaching presence (Garrison et al., 2000). Therefore, even if learners can stay connected digitally, they may still feel isolated, and learning loneliness lowers intrinsic motivation and engagement (Yıldırım et al., 2024; Ramli et al., 2024).

In this situation, SWM videos appear as an unprecedented mode of online learning-being long, interactive, and minimalist. It does not provide instructions but provides

opportunities for learners to make their own learning environment, receive emotional support, and maintain their motivation with the help of companionship or "studying together" from people in the videos (Lee et al., 2021; Ren et al., 2025).

Mediated presence, online engagement, and technology appropriation for learning are all concepts that are sufficiently described within HCI and information sciences. SWM research has examined how viewers personalize ambience and experience illusionary presence (Lee et al., 2021). The present study complements this work by examining associations among reported relational, emotional, and learning experiences within an experienced-viewer sample. It does not establish that low-interaction companionship is a new phenomenon or compare its effectiveness with reciprocal learning environments.

In an effort to bridge this gap, this research proposes to frame "Study with me" (SWM) videos as a form of mediated companionship and explores the relationships between learners' co-presence, parasocial interaction, their perceived learning loneliness reduction, motivation, and learning persistence.

> *RQ1*: Is there any relationship between SWM video viewing experience and perceptions of co-presence and parasocial interaction among experienced viewers?
>
> *RQ2*: How are these relational perceptions related to learning loneliness reduction?
>
> *RQ3*: Are there any associative, predictive or exploratory configurational patterns that can link these perceptions with learning motivation and persistence?

This paper provides a tentative account of SWM companionship from the perspective of Human Computer Interaction, Information Science and Media/ Educational Psychology.

Literature review

Emotion regulation and relational disconnection in online learning

Despite the fact that online learning can overcome barriers to time and place, online learning is a more individualized and decontextualized learning experience with less interaction among individuals. Moore (1993) contends that distance education has both physical and psychological dimensions. Garrison et al. (2000) further proposed that social, cognitive, and teaching presence jointly shape online learning quality. Where interactive support and emotional responsiveness are lacking, learners are more prone to emotional fluctuation, loneliness, and alienation, which ultimately diminish engagement.

In online learning, emotion regulation involves managing negative emotions—loneliness, anxiety, boredom, frustration—and maintaining psychological stability and sustained engagement. Loneliness in digital learning reduces satisfaction and significantly undermines intrinsic motivation and long- term participation (Hawkley and Cacioppo, 2010; Yıldırım et al., 2024). Fostering companionship and relational interaction in low-interaction environments has thus become an important issue in digital learning research.

HCI and information science perspectives

HCI distinguishes mediated experience from a simple reproduction of face-to-face contact, making the needs and mechanisms of a particular practice central to analysis (Hollan and Stornetta, 1992). Social-presence research provides the grounds for investigation of access perception to others; however, the concept of social presence should not be confused with the notion of interpersonal attachment (Biocca et al., 2003). Hence, SWM viewing is considered here as the example of use practice characterized by comparatively low levels of direct communication alongside with the sense of accompaniment.

Online-community research defines the differences between interface usability and sociability, takes into account reciprocity, trust, participation, and members' experience (Preece, 2001). Reader-to-leader framework distinguishes reading from contribution, collaboration, and leadership (Preece and Shneiderman, 2009). Applied in a comparison, these approaches warn against misinterpretation of low visible participation as lack of social experience, or treating an accompanied viewer as the member of the reciprocal community. The present study did not assess the level of participation in the community or belonging to it.

There is a body of literature on how broadcast media and chat allow the formation of participatory communities (Hamilton et al., 2014); the CSCW literature describes the use of livestreaming platforms for education purposes (Chen et al., 2020). The findings serve as a comparison point but not as direct information about SWM: the present survey does not analyze the difference between live and prerecorded viewing, chat use, and reciprocal interactions.

SWM as a type of mediated companionship

SWM videos represent online media wherein the creator records himself while studying. Such videos tend to be long, interactive in a minimal way, and visual with few elements, representing silent or noiseless studying sessions. In contrast to instructional videos, SWM videos do not seek to provide any information. Instead, they try to provide company to solitary learners through studying habits, a steady rhythm, and an immersive environment. Viewers use such videos not only for learning purposes but also to create an immersive environment for studying, help them concentrate, keep the steady rhythm, and lessen the feeling of loneliness while studying alone (Lee et al., 2021).

Sense of togetherness and light connection presence

The concept of co-presence theory provides insight into why SWM watchers might feel accompanied despite the lack of direct interaction. In mediating situations, the presence of someone else does not have to be a result of physical proximity or intensive interaction but can occur as a result of vision, repeated actions, time and theambience of the medium (Biocca et al., 2003; Nowak and Biocca, 2003). The concept is associated with connected presence, which means that communication through mediation allows maintaining social connectedness in daily life (Licoppe, 2004). Light connection presence shares the features of weak ties as being low-intensity, low obligation, and emotionless (Granovetter, 1973), although it is different from both because it does not require reciprocity in the case of connected

presence and does not involve any real relations or networks in the case of weak ties.

Light connection presence is used here as an SWM-specific description of mediated co-presence, rather than a validated new construct. It concerns the perception that another person is studying alongside the viewer. Social presence provides the broader theoretical background (Biocca et al., 2003), while the present operationalization focuses narrowly on perceived shared study and accompaniment. Connected presence concerns ongoing mediated relationships (Licoppe, 2004), and weak ties describe actual social relationships (Granovetter, 1973); neither actual reciprocity nor a social-network tie is established by the present CP items. Incremental validity beyond neighboring presence concepts has not been demonstrated.

Parasocial interaction and relationship in SWM viewing

Parasocial interaction refers to an interaction-like experience during media exposure, whereas parasocial relationship concerns a more enduring one-sided connection extending beyond a viewing episode (Dibble et al., 2016). Repeated viewing may be relevant to familiarity or relationship development, but does not itself demonstrate either process. The present retained items mix perceived interaction without direct communication and familiarity after long-term viewing. We therefore use the descriptive label parasocial experience for this provisional mixed operationalization. This label does not establish a validated higher-order construct and cannot resolve the distinction between interaction and relationship. Intimacy, attachment, and enduring relationship strength were not separately established.

Emotion regulation, learning motivation, and learning persistence

Loneliness is a subjective discrepancy between desired and experienced social connection, rather than the objective fact of studying alone (Hawkley and Cacioppo, 2010). Learning-related loneliness locates that experience within study activities. Perceived alleviation of learning-related loneliness refers here to respondents' reports that studying with SWM videos feels less lonely. Perceived emotional support concerns comfort, care, or assistance and is conceptually distinct; it was not separately measured.

Prior associations between loneliness and lower motivation do not establish an equal and opposite mechanism for perceived learning loneliness alleviation. Self-determination theory offers a rationale for expecting experiences relevant to relatedness to covary with motivation (Ryan and Deci, 2020), but relatedness satisfaction was not measured. We therefore hypothesize an association between perceived relief and motivation without assuming that relief is the reverse of baseline loneliness or that emotional support mediates this association.

The loneliness-related items ask respondents to attribute relief to SWM viewing. They do not measure baseline loneliness or within-person change over time. Motivation and persistence are likewise self-reported, and their association with attributed relief may reflect shared evaluations, selection into viewing, or unmeasured support and study conditions.

Conceptual organization and development of the hypotheses

Figure 1 illustrates an initial organization of concepts derived from the literature; Figure 2 depicts some concepts mapped to research hypotheses on observed relationships. These are complementary illustrations, not competing theories. The organization include media usage, relational perception, emotion, and learning engagement. It was inspired by the narrative literature discussed in the previous section, rather than developed via a systematic literature review, qualitative analysis, or any other valid process. The following mapping clarifies the logic of this contribution without retracing the steps of the nonexistent development process. The contribution is therefore an application-specific integration for research, not an original theory of the process constructed in this study.

Concepts to hypotheses mapping: Media usage is illustrated via frequency, active usage, and habitual SWM viewing (VU), as the rationale is provided by Lee et al. (2021). This concept inspires H1 and H6; visible rhythm and viewing duration are potential explanations but not independent constructs.

Relational perception is represented by CP, grounded in mediated co-presence (Biocca et al., 2003; Nowak and Biocca, 2003), and the provisional parasocial measure, interpreted using the interaction–relationship distinction (Dibble et al., 2016). These concepts motivate H2, H3, and H7. The retained items support only narrow, overlapping operationalizations.

Representation of the emotion is the perceived alleviation of learning loneliness (LON) based on the existing literature on loneliness (Russell, 1996; Hawkley and Cacioppo, 2010). The representation of the learner engagement is the motivation (MOT) and persistence (PER), based on the literature on motivation and persistence research (Guay et al., 2000; Ryan and Deci, 2020; Joo et al., 2011; Roca et al., 2006). These links motivate H4, H5, and H8. Emotional support and relatedness satisfaction are unmeasured theoretical possibilities, not demonstrated intervening variables.

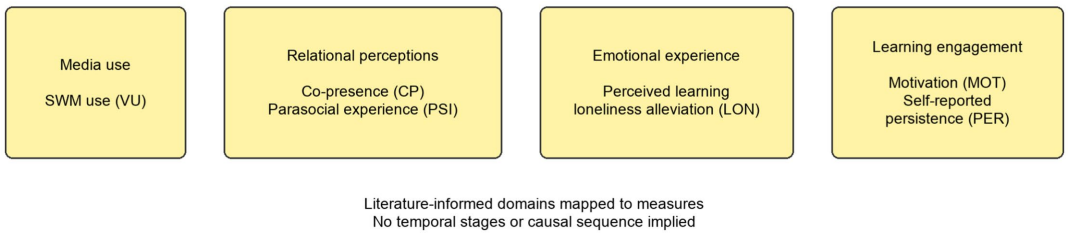

FIGURE 1
Conceptual organization of mediated companionship in SWM viewing. Domains organize the literature; they do not specify temporal stages.

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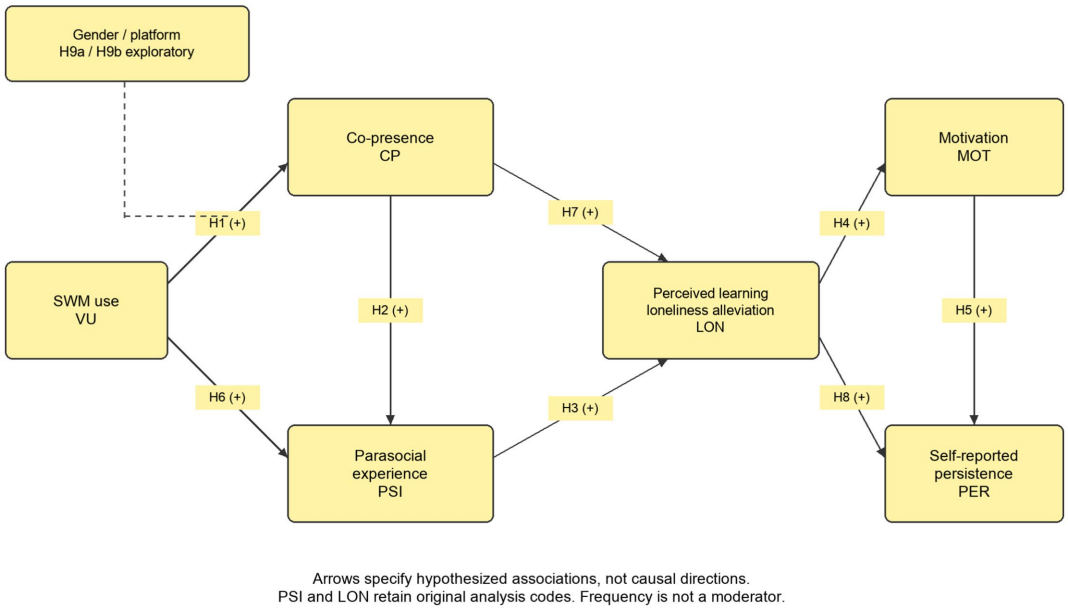

FIGURE 2
Hypothesized associations among the measured constructs. Positive signs express hypotheses, not established effects. (H9a, H9b) are exploratory moderation questions. Frequency remains a control in Table 1, not a moderator. The additional VU–LON estimate is exploratory and is not drawn as a hypothesis.

TABLE 1 Structural path and moderation results.

Path	β	t	p	Result
VU → CP	0.456	3.788	<0.001	H1 supported
CP → PSI	0.387	4.670	<0.001	H2 supported
PSI → LON	0.308	3.373	<0.001	H3 supported
LON → MOT	0.491	8.979	<0.001	H4 supported
MOT → PER	0.543	7.536	<0.001	H5 supported
VU → PSI	0.260	3.191	0.001	H6 supported
CP → LON	−0.136	1.144	0.253	H7 not supported
VU → LON	0.298	3.251	0.001	Exploratory association
LON → PER	0.204	3.112	0.002	H8 supported
Gender → CP	0.139	1.269	0.204	Not significant
Platform → CP	−0.069	1.398	0.162	Not significant
Frequency → CP	0.040	0.642	0.521	Not significant
Gender x VU → CP	0.286	1.608	0.108	H9a not supported
Platform x VU → CP	0.076	1.068	0.286	H9b not supported

β = standardized path coefficient. The term "supported" refers to statistically significant associations, not confirmed causal effects.

Research hypothesis

Figure 2 is an implementation of Figure 1 by means of VU, CP, the provisional measure of parasocial experience measure (original code PSI), perceived learning reduction of loneliness alleviation (original code LON), MOT, and PER. The original codes have been maintained in order to keep correspondence with available estimates and analysis materials. H1–H8 concern model-specified associations; arrow orientation is an analytical specification rather than evidence of temporal order. Gender and platform interactions are retained as exploratory boundary questions (H9a, H9b).

Visible study activity and a perceived shared rhythm motivate an expected association of SWM use with CP (H1). Co-presence may coexist with interaction-like experience or familiarity, motivating H2 and H6 without assuming relationship formation. Relational perceptions may covary with attributed emotional relief (H3 and H7). The relatedness rationale motivates H4, while accounts of sustained engagement motivate H5 and H8. None of these rationales substitutes for direct tests of temporal change. The additional VU–LON coefficient reported in Table 1 was not among H1–H8 and is interpreted as an exploratory additional association.

H1: Companion video use is positively associated with light connection presence.

H2: Light connection presence is positively associated with parasocial experience.

H3: Parasocial experience is positively associated with perceived learning loneliness alleviation.

H4: Perceived learning loneliness alleviation is positively associated with learning motivation.

H5: Learning motivation is positively associated with learning persistence.

H6: SWM video use is positively associated with parasocial experience.

H7: Light connection presence is positively associated with perceived learning loneliness alleviation.

H8: Perceived learning loneliness alleviation is positively associated with learning persistence.

H9a: Gender moderates the relationship between SWM video use and light connection presence.

H9b: Platform moderates the relationship between SWM video use and light connection presence.

Research methods

Survey and sample

This study used an online questionnaire to measure learners' relational perceptions, emotional experiences, and behavioral tendencies when using SWM videos. The questionnaire was distributed through Wenjuanxing, with voluntary participation. For the current research that focuses on individuals with companion-style learning videos experience, only the answers of those with previous experience have been included into the primary analysis.

The survey period took place between March 26 and May 1, 2026. Out of 317 questionnaires obtained, 73 were rejected because of lack of any SWM viewing experience; therefore, the number of valid responses used for the analysis was 244. The final sample included 105 males (43.0%) and 139 females (57.0%). The majority of respondents were students of undergraduate level, senior year being the biggest group (33.6%). The most popular average time spent on studying per day was 2–4 h (30.3%), then 1–2 h (25.0%). The sample of the current research has been obtained via the online survey and included primarily university students who had SWM viewing experience. Therefore, it can be viewed as an experience-based sample and notas representative one.

While the sample size of 244 may be adequate for estimating the association model, it is relatively small considering that this study is concerned with the investigation of directional structure, predictive power outside the sample, and set theoretic designs. The non-PLS analysis can thus be considered exploratory, and repetition with a larger sample size would be advisable.

Measurement

For the analysis of six main variables-ues of SWM videos (VU), light connection presence (CP), parasocial interaction (PSI), perceived learning loneliness reduction (LON), learning motivation (MOT), and learning persistence (PER), questions were asked based on previously validated scales, which were slightly modified for SWM. Contextual adaptation does not establish content or construct validity, particularly after same-sample indicator deletion. Full measurement details are reported in Supplementary information 1.

SWM video use (VU) comprises four retained items about frequency, active use, and habitual use. CP comprises two retained items about perceived shared study and accompaniment. The provisional parasocial experience measure retains the code PSI and comprises one interaction-like item and one familiarity item; it is not a distinct validated measure of PSI, parasocial relationship, intimacy, or attachment. LON comprises four items about perceived alleviation of learning-related loneliness attributable to viewing. Its adaptation from loneliness research changes the target from loneliness level to perceived relief; citing Russell (1996) does not establish validation of this adapted relief measure. MOT comprises three items about willingness to begin or continue study. PER consists of four items pertaining to sustained study, distractions, planned tasks, and rhythm, but does not constitute an observable behavioral consequence. These details are provided in the Supplementary information 1.

Data analysis

PLS-SEM is the primary hypothesis-oriented association analysis. Because indicators were reduced using the same sample, it is not an independent confirmatory validation of the measurement model or theory. DirectLiNGAM and RCD explore assumption-dependent directional patterns. Non-recursive SEM compares alternative LON–MOT specifications but supplies no inferential evidence for reciprocity because identification, exclusion restrictions, and equilibrium assumptions were not adequately documented in the retained analysis record. Machine learning assesses designated prediction tasks in held-out folds; it does not compare reverse causal models. fsQCA explores calibration-dependent set configurations. All methods reuse the same self-reported observations and inherit their measurement, selection, and common-method limitations. Agreement is descriptive complementarity, not independent replication. Disagreement limits interpretation within the relevant task: a significant association may coexist with uncertain direction, and predictive importance cannot adjudicate that direction.

PLS-SEM and directional sensitivity analysis

PLS-SEM estimates the specified associations with 5,000 bootstrap resamples. Hypothesis labels are retained for correspondence with the original model, while indicator deletion and gender/platform moderation are explicitly qualified as data-informed or exploratory. DirectLiNGAM and RCD are supplementary explorations, not causal validation. DirectLiNGAM assumes a linear acyclic model with non-Gaussian independent disturbances and no latent confounding; RCD permits particular latent-confounding structures under its own assumptions (Shimizu et al., 2011; Maeda and Shimizu, 2020). Marginal distribution and dependence diagnostics do not verify these identifying assumptions. The non-recursive comparison is retained only as a descriptive record in Supplementary information 2, not as evidence favoring one temporal or reciprocal mechanism.

Machine learning analysis

Machine learning examined the predictive role of the core variables. Random Forest and gradient-boosting tree models were chosen to capture nonlinear relationships and interactions. Learning persistence was the primary outcome, and other endogenous constructs were examined in supplementary prediction tasks. To improve interpretability, SHAP values identified each predictor's relative contribution, and partial dependence plots visualized the marginal relationships between key predictors and outcomes.

fsQCA analysis

Fuzzy-set qualitative comparative analysis (fsQCA) was conducted in R using the QCA package (version 3.25). The initial exploratory analysis directly calibrated standardized SmartPLS latent scores at the empirical 5th percentile (full non-membership), zero (crossover), and 95th percentile (full membership). These distribution-based anchors do not define substantively validated set membership. We therefore performed an additional sensitivity analysis using means of the retained original 1–5 response items for the 244 eligible respondents. Response-category anchors of 2/3/4 (disagree/neutral/agree) and a stricter high-agreement specification of 3/3.5/4 were examined. Because many construct means equaled a crossover, both 0.499 and 0.501 membership assignments for exact ties were tested. High LM used VU, CP, PSI, and LA as conditions; high LP additionally used LM. The necessity threshold was 0.90. Truth tables used frequency ≥3, sufficiency consistency ≥0.80, and PRI ≥ 0.70, with positive directional expectations for intermediate solutions. The response-category anchors are substantively interpretable but not independently validated construct thresholds. All fsQCA results are therefore exploratory; the full calibration comparison is reported in Supplementary information 2.

Results

PLS-SEM results

SmartPLS 4 was used to examine the structural model. Results are reported in four parts: measurement model assessment, common-method bias and discriminant validity, structural model explanatory power, and hypothesis testing. Bootstrapping with 5,000 resamples assessed the significance of path coefficients.

The measurement model was assessed for indicator reliability, internal consistency, convergent validity, and discriminant validity. Outer loadings of retained indicators ranged from 0.754 to 0.882 and were significant. However, measurement of light connection presence and parasocial experience remains provisional. In the initial 24-item covariance-based CFA, the estimated CP-PSI latent correlation was 1.005 and the latent covariance matrix had a negative eigenvalue, indicating an inadmissible solution and insufficient empirical separation. The final PLS-SEM retained CP1 and CP3 for CP and PSI2 and PSI4 for PSI after five items were removed in the same sample. The retained pairs showed alpha = 0.694 and 0.712, composite reliability = 0.867 and 0.874, and AVE = 0.766 and 0.777, respectively. These statistics describe internal consistency of the reduced measures but do not resolve the original discriminant-validity problem or the risk of sample-specific item selection. CP and PSI are therefore treated as theoretically distinct but empirically provisional dimensions. A broader item pool and independent confirmatory sample are required before strong claims of distinctness can be made.

All constructs were measured from the same respondents in one blocked questionnaire at one time. Harman's first factor accounted for 43.04% of variance, but this result does not rule out common-method variance and should not be interpreted through a mechanical 50% cutoff. Same-source covariance, consistency motifs, and halo effects may have inflated the observed associations. Future studies should use temporal or psychological separation, a prespecified marker variable, randomized or interspersed item presentation where appropriate, and multi-source or behavioral outcomes such as study-session duration and return behavior. A latent method-factor analysis should also be considered when the measurement design and sample size support it.

HTMT values in the reduced PLS-SEM model were below 0.85, but this same-sample result does not override the inadmissible original CFA or establish firm empirical separation between CP and PSI. The HTMT matrix is reported as descriptive evidence for the retained model, while construct distinctness remains provisional pending independent validation.

The structural model's explanatory power was evaluated with R^2. As shown in Table 2, the model explained 42.8% of the variance in light connection presence, 33.9% in parasocial experience, 27.4% in perceived learning loneliness alleviation, 24.1% in learning motivation, and 44.5% in learning persistence.

The reported R^2 values describe within-sample explained variance under the fitted specification. VIF values below 5 describe collinearity in that specification but do not resolve the original CP–PSI

TABLE 2 Measurement model and explanatory power.

Construct	Cronbach's alpha	rho_c	AVE	Highest HTMT	R^2	Adjusted R^2
VU	0.881	0.917	0.735	0.779	–	–
CP	0.694	0.867	0.766	0.820	0.428	0.411
PSI	0.712	0.874	0.777	0.786	0.339	0.334
LON	0.879	0.916	0.731	0.590	0.274	0.268
MOT	0.789	0.875	0.700	0.811	0.241	0.238
PER	0.794	0.864	0.613	0.820	0.445	0.440

VU = SWM video use; CP = light connection presence; PSI = parasocial experience; LON = perceived learning loneliness alleviation; MOT = learning motivation; PER = learning persistence. Highest HTMT refers to the highest HTMT value involving each construct.

discriminant-validity problem, indicator-selection bias, or shared-source covariance.

Structural paths and moderating effects were examined with bootstrapping using 5,000 resamples. Table 1 reports the path coefficients, *t*-statistics, *p*-values, and hypothesis-testing results. Because the data are cross-sectional and self-reported, "supported" denotes a statistically significant association in the hypothesized model rather than confirmed causation (Rindfleisch et al., 2008).

Support for H1: SWM video use was significantly and positively associated with light connection presence ($\beta = 0.456$, $p < 0.001$), indicating that more frequent, habitual SWM users more often experience a mediated sense of studying together.

Support for H2: Light connection presence was significantly and positively associated with parasocial experience ($\beta = 0.387$, $p < 0.001$); this is a statistical association within the model, not evidence of a confirmed causal sequence.

Support for H3: Parasocial experience was significantly and positively associated with perceived learning loneliness alleviation ($\beta = 0.308$, $p < 0.001$), indicating that stronger familiarity and connection with the creator accompany greater perceived learning loneliness alleviation.

Support for H4: Perceived learning loneliness alleviation was significantly and positively associated with learning motivation ($\beta = 0.491$, $p < 0.001$).

Support for H5: Learning motivation was significantly and positively associated with learning persistence ($\beta = 0.543$, $p < 0.001$).

Support for H6: SWM video use was positively associated with parasocial experience ($\beta = 0.260$, $p = 0.001$). This association does not demonstrate that repeated exposure produces familiarity or an enduring relationship.

Non-support for H7: The CP–LON coefficient was not significant ($\beta = -0.136$, $p = 0.253$). This does not establish that co-presence lacks emotional value.

Support for H8: Perceived learning loneliness alleviation had a significant positive direct association with learning persistence ($\beta = 0.204$, $p = 0.002$).

Gender and platform did not significantly moderate the association between SWM video use and light connection presence; therefore, H9a and H9b were not supported. The previously specified frequency moderation test was removed because habitual/frequent use is already part of the VU construct, making frequency an overlapping rather than independent moderator.

Overall, the PLS-SEM results support several significant associations among the six constructs. Because the data are cross-sectional and self-reported, they should not be read as a fixed causal chain; directional stability is examined next through causal discovery.

Directional sensitivity analysis

LiNGAM and RCD were used only as exploratory directional sensitivity analyses. Their assumptions include linear structural relations, non-Gaussian disturbances, acyclicity, and either absence of unmeasured confounding or adequate treatment of latent confounding. These assumptions cannot be established from the present cross-sectional, same-source survey. Accordingly, detected edges are not interpreted as causal effects. Disagreement between the algorithms for CP-PSI and LON-MOT indicates unresolved direction and reinforces the need for longitudinal or experimental data. Detailed diagnostics are reported in the Supplementary information.

All core construct scores departed from marginal normality in Jarque–Bera tests (Supplementary information 2). This is a descriptive diagnostic, not evidence that structural disturbances are non-Gaussian and independent or that the other causal-identification assumptions hold.

Distance and Pearson correlations provide exploratory descriptions of dependence. Similar magnitudes do not establish linear structural relations, acyclicity, or absence of confounding. Algorithmic directions therefore remain conditional outputs rather than identified causal relations.

Algorithm selection and directional sensitivity results

DirectLiNGAM estimates an algorithmic ordering under linear non-Gaussian and no-unmeasured-confounding assumptions, whereas RCD allows certain latent-confounding structures (Maeda and Shimizu, 2020; Shimizu et al., 2011). In this study, both outputs are treated only as directional sensitivity results, not as estimates of causal effects.

Panel A of Table 3 records the reported algorithmic outputs separately. Their agreement is not independent evidence, while disagreement for CP–PSI and LON–MOT leaves ordering unresolved.

Interpretation of directional sensitivity results

Both algorithms returned VU → CP. Agreement within the same dataset does not identify an exposure effect or rule out selection, reverse influence, or common causes.

Because causal discovery did not yield consistent CP–PSI directions, a sensitivity analysis examined whether the theoretically specified CP → PSI path was directionally stable across different assumptions. The detailed bootstrap-stability results are reported in the Supplementary information.

DirectLiNGAM returned PSI → CP with 46% bootstrap stability, while RCD returned CP → PSI with 60% stability. These frequencies indicate instability. The methods impose different assumptions; their disagreement neither identifies latent confounding nor establishes which direction is correct.

Media attachment, digital social orientation, and anthropomorphism are possible unmeasured common causes, not explanations established by this study. Reporting two algorithms makes the sensitivity visible but does not remove confounding or measurement error.

CP and parasocial experience are associated but have uncertain empirical separation and ordering. Directional disagreement does not establish reciprocity, a feedback loop, or a network structure.

Additional exploratory edges involving persistence

Two additional edges, CP-PER and LON-PER, appeared in both algorithms. Their recurrence may guide future hypotheses, but the cross-sectional sensitivity analysis cannot show that either construct causes persistence. Longitudinal data should test whether these patterns reproduce after temporal ordering and relevant confounders are measured.

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TABLE 3 Exploratory directional patterns and supplementary prediction summary.

Panel A. Exploratory directional outputs			
Relationship	DirectLiNGAM result	RCD result	Interpretation
VU → CP	+0.412	+0.608	Consistently detected
CP-PSI	PSI → CP (+0.288)	CP → PSI (+0.450)	Directionally ambiguous
PSI → LON	+0.178	+0.323	Consistently detected
LON-MOT	MOT → LON (+0.239)	LON → MOT (+0.321)	Directionally ambiguous
CP → PER	+0.608	+0.419	Newly detected path
LON → PER	+0.470	+0.264	Newly detected path

Panel B. Random forest predictive performance			
Target construct	R^2(CV)	Strongest predictor	Mean |SHAP|
PER	0.489	VU	0.209
CP	0.404	VU	0.366
MOT	0.391	LON	0.184
LON	0.242	VU	0.231

Causal discovery results are exploratory and should not be interpreted as definitive causal proof. R^2 (CV) indicates cross-validated predictive performance in the Random Forest model.

Sensitivity analysis of the directional ambiguity between perceived learning loneliness alleviation and motivation

A one-way and a reciprocal LON–MOT specification were previously estimated using semopy. Their fit summaries are retained in Supplementary information 2 as a descriptive analysis record. Adequate documentation of identification, exclusion restrictions, disturbance assumptions, and equilibrium stability was not available; the comparison is therefore not used to infer directional or reciprocal effects.

The reported one-way estimate was $\beta = 0.105$ ($p = 0.035$), while neither reciprocal path was significant in the alternative specification. Differences in fit indices or information criteria cannot establish temporal ordering and are not treated as evidence favoring one mechanism. LON–MOT direction remains unresolved.

Supplementary machine learning prediction

Random Forest prediction, SHAP values, permutation importance, and partial dependence plots describe the designated prediction tasks. Reported cross-validated R^2 was 0.489 for PER, 0.404 for CP, 0.391 for MOT, and 0.242 for LON. Tuning and evaluation were not nested, so these values remain exploratory and potentially optimistic. No predictive result establishes causal direction or independently validates the association model.

In the prespecified machine-learning models, SWM video use was the strongest predictor of light connection presence, perceived learning loneliness alleviation, and learning persistence, and an important predictor of parasocial experience and learning motivation. This pattern supports the proposed use-to-outcome predictive specification. It does not determine whether SWM use temporally precedes these experiences: learners with stronger motivation or persistence may also use SWM videos more frequently.

In the designated learning-motivation prediction task, perceived learning loneliness alleviation had the largest reported mean SHAP value (0.184). This describes contribution to that fitted prediction, not evidence that relief precedes or causes motivation. Reverse models were not compared.

In the persistence prediction task, reported cross-validated R^2 was 0.489 and SWM video use was the strongest predictor. Predictor rankings and PLS-SEM coefficients address different questions and should not be read as confirming emotional mediation or the effectiveness of a viewing routine.

The reported cross-validated R^2 for LON was 0.242. This indicates limited prediction in this sample and specification, rather than identifying omitted psychological mechanisms. Independent samples and validation that includes all preprocessing and score estimation within training folds are required to assess generalization.

Fuzzy-set qualitative comparative analysis

The original percentile-calibrated fsQCA examined configurations associated with high learning motivation and persistence. Under that specification, no single antecedent reached the 0.90 necessity-consistency threshold. The pathways below apply only to the original calibration and do not establish substantive necessity or causation.

Under the original percentile-based calibration and truth-table thresholds (frequency ≥3, consistency ≥0.80, PRI ≥ 0.70), intermediate minimization yielded two configurations for high LM and three for high LP. Table 4 describes this single exploratory specification; it should not be interpreted as a set of calibration-invariant pathways.

Under the original percentile-based calibration, two high-LM configurations were obtained: VU*CP*PSI (consistency = 0.926; raw coverage = 0.649) and CP*PSI*LA (consistency = 0.923; raw coverage = 0.613). Overall solution consistency was 0.916 and coverage was 0.679. These statistics describe that specification only; the original-scale sensitivity analysis did not support treating either expression as a stable pathway.

CP and PSI appeared together in both percentile-calibrated high-LM configurations, but neither was individually necessary. Because

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TABLE 4 Exploratory percentile-calibrated fsQCA configurations for high learning motivation and persistence.

Outcome	Configuration	Formula	Raw coverage	Unique coverage	Consistency
High LM	M1	VU(C) x CP(C) x PSI(C)	0.649	0.066	0.926
High LM	M2	CP(C) x PSI(C) x LA(C)	0.613	0.030	0.923
High LP	P1	VU(C) x CP(C) x PSI(C) x LA(P)	0.599	0.032	0.950
High LP	P2	VU(C) x CP(C) x PSI(C) x LM(P)	0.629	0.062	0.959
High LP	P3	VU(C) x PSI(C) x LA(C) x LM(C)	0.612	0.045	0.940

C = core condition; P = peripheral condition; multiplication indicates conjunction. For high LM, overall solution coverage = 0.679, overall consistency = 0.916, and overall PRI = 0.851. For high LP, overall solution coverage = 0.706, overall consistency = 0.930, and overall PRI = 0.862. Conditions absent from a formula are irrelevant to that pathway.

original-scale recalibration changed the solutions, this co-occurrence is specific to the initial calibration and does not establish a stable relational mechanism or temporal sequence.

Under the same original percentile-based calibration, high LP yielded VU*CP*PSI*LA, VU*CP*PSI*LM, and VU*PSI*LA*LM. Their respective consistencies were 0.950, 0.959, and 0.940, with raw coverages of 0.599, 0.629, and 0.612. Overall solution consistency was 0.930 and coverage was 0.706. Core and peripheral designations in Table 4 are specific to this minimization and should not be generalized across calibration choices.

Calibration sensitivity substantially qualified these findings. With original-scale means and 2/3/4 anchors, assigning exact crossover ties to 0.501 produced a degenerate minimization in which all truth-table configurations were used; assigning ties to 0.499 yielded CP + LA for high LM and LM for high LP. Under stricter 3/3.5/4 anchors, the high-LM solution was LA + VU*CP + CP*PSI at 0.501 and VU + PSI + LA at 0.499; the corresponding high-LP solutions also differed. Thus the percentile-calibrated pathways in Table 4 did not consistently reproduce under response-category anchors. We treat fsQCA as an exploratory sensitivity analysis, not evidence of stable sufficient recipes. Full solutions, consistency, coverage, and code are provided in Supplementary information 2 and the reproducibility materials.

Discussion

Mediated presence and parasocial experience in SWM viewing

Usage of SWM correlated with co-presence perception and the tentative measure of mixed parasociality. Co-presence refers to joint study and companionship, whereas the latter is a combination of interaction experience and familiarity. There was no evidence of the role played by continuity, rhythm, and repetitive exposure in these perceptionssince these features and temporal processes were not investigated.

The significant correlation between CP-PSI goes hand-in-hand with construct underdifferentiation and non-reliability. Such results encourage future measurement studies but do not prove any sequencing or reciprocal relationships.

Interpretation of the unsupported H7

While H7 was rejected, the conclusion should not be taken as a basis to claim that mediated co-presence is not capable of reducing loneliness. The lack of a significant direct effect might be due to the shorter two-item CP scale, the poor empirical distinction between CP and PSI, the presence of shared predictor variance, lack of statistical power, or an indirect relationship. Hence, what the study has done is to refute the hypothesized sequential model instead of proving that light connection presence not an effective emotional presence.

Emotion regulation, learning motivation and learning persistence

Perceived learning loneliness relief was positively correlated with motivation. That is in line with a relatedness perspective interpretation, but no satisfaction with relatedness and emotional support were individually evaluated. Relief is not a reduction of loneliness, and the negative consequences of loneliness do not prove the reverse positive effects.

The causal relationship between perceived relief and motivation has yet to be resolved. Individuals who are more motivated can evaluate watching better, or both reports can be linked to other factors that have not been considered. Neither algorithmic instructions nor the inadequate reciprocal definition resolve this choice.

Both motivation and perceived relief had correlations with persistence as reported by the learners. These coefficients do not demonstrate the direct and indirect mechanism of emotions, persistence that has been validated, or better task performance. The use of similar wording in the motivation questions is another factor.

Boundary conditions: gender and platform

Gender and platform were considered as exploratory boundary conditions because access patterns and platform affordances might affect users' perceptions of mediated presence; this study was not sufficiently powered to test a sufficiently developed moderation theory. Since frequency overlaps theoretically and methodologically with habitual and frequent SWM usage, it was excluded from further analysis as a moderator and is considered only as a control variable. Consequently, nonsignificant interaction results cannot be used as an argument in favor of the absence of gender and platform influences on mediated presence.

Theoretical implications

The current study enriches information about the mediated presence and practices of participation, and learning from the perspective of HCI and information science with the examination of associations

within low-interaction SWM viewing. It relies upon the practices described by Lee et al. (2021) and makes an attempt to establish the connection between these practices and learning and emotional experiences. It neither questions the importance of reciprocal communities nor proves that interaction is unnecessary for learning. Light connection presence is an attempt at a contextual description of which incremental validity has not been tested.

Conceptual organization and hypotheses model can be considered as complementary analytical tools. Conceptual organization includes literature-based domains; hypotheses model includes estimated associations. No formal network analysis, longitudinal process analysis, or independent theory validation has been performed. Disagreements and calibration-sensitive configurations restrict the theoretical conclusions.

Practical implications

Calm atmospheres, stable visual presence, time structures, and viewing routines can become the subjects of future design research but not the elements proven to be effective in this survey. Habitual use is included into use construct, but it does not prove the importance of the encouragement of routine. Future experimental researches can vary video features separately, and longitudinal field studies can include the measurement of viewing and loneliness assessments along with behavioral study duration, interruptions, and task completion. The present findings support investigating these possibilities rather than recommending interventions.

Limitations and future research

First, the analysis involved a same-source, cross-sectional design and a sample size of 244. The design precludes the possibility of inferring temporality and/or rule out the potential for common-method bias while a sample of this size is rather small for directional discovery and machine-learning robustness, fsQCA configurations and minor interaction effects. The 46% and 60% frequencies of the contested CP-PSI direction in the bootstrapping analyses suggest these directions are not confirmed but rather are unsteady. A larger and independent sample size, temporally separate designs, behavioral outcome measures and longitudinal and/or experimental designs are needed for future studies. A recalibration of the original-scale fsQCA solution also affected the terms in the solution, and the exact crossover ties in the fsQCA also altered the minimization process, which means those configurations should be considered exploratory rather than robust paths of substantive interest.

Second, the LON measure captures the reported relief a person receives in an attributed manner rather than as changes in loneliness that are measured over time and separate measures for emotional support and relatedness satisfaction were not employed. Future studies should separate general loneliness and learning-related loneliness and should employ multiple assessment of each construct. Offline social support and other common causes of relatedness should also be examined. The items adapted to assess motivation and persistence were also the same in that they both contain similar content regarding continuing study and this could inflate their apparent association.

Third, CP and the parasocial measure each retain only two items after same-sample deletion. The original inadmissible CFA and CP–PSI correlation above one undermine strong claims of separation. The parasocial pair additionally mixes interaction and accumulated familiarity; a descriptive relabeling does not correct that content-validity problem. Separate validated measures of exposure-specific interaction, enduring relationship, and neighboring constructs are needed in an independent sample. The conceptual organization is literature-informed rather than systematically derived, and the multiple analyses are not independent validation. Non-recursive identification was not adequately documented and its fit comparison has no directional evidential role.

Finally, the study focused on learners with prior SWM viewing experience, so findings may not generalize to all online learners. Future research could compare viewers and non-viewers or examine whether different SWM video types produce different levels of mediated companionship.

Conclusion

Based on 244 experienced SWM viewers, this study found that there are several statistically significant associations between video use, perceived co-existence, quasi-social experience, perceived loneliness relief associated with learning, motivation, and self-reporting persistence. However, these results reflect the perceived correlation in the sample, which does not mean that SWM viewing itself has an impact.

Among them, the subsocial-LON coefficient is significant, while the CP-LON coefficient is not significant, which is not enough to determine which kind of relationship process produces emotional relief. The reason why the explanation is limited is also because the CP-PSI separation is weak, the content of quasi-social projects is mixed, the source of measurement sharing and the sorting is uncertain. The study provides only a temporary, literature-based organisational framework and corresponding association model, which neither establishes a fixed causal chain nor a dynamic network. Therefore, independent measurement and verification, as well as longitudinal or experimental research, are needed before making suggestions on relationship development, loneliness reduction or effective video design.

Data availability statement

The data supporting the findings of this study are publicly available in Science Data Bank (ScienceDB) under DOI 10.57760/sciencedb.40220 and can be accessed at https://www.scidb.cn/s/ymuYRv.

Ethics statement

Ethical approval for this study was granted by the Research Ethics Committee of Beijing Normal-Hong Kong Baptist University (Ref. No. REC-2026-45). All procedures involving human participants were conducted in accordance with applicable institutional ethical standards. The confidentiality and anonymity of the participants and their responses were maintained throughout the research process. Informed consent was obtained from all participants before they completed the questionnaire. Participation was voluntary, and participants were informed of the purpose of the study, the confidentiality of their responses, and their right to discontinue participation at any time.

Author contributions

FL: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Visualization, Writing – original draft. YD: Supervision, Conceptualization, Writing – review & editing. YL: Investigation, Data curation, Writing – review & editing. YZ: Investigation, Data curation, Visualization, Writing – review & editing. KF: Supervision, Project administration, Funding acquisition, Conceptualization, Writing – review & editing.

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Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declared that Generative AI was not used in the creation of this manuscript.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2026.1946086/full#supplementary-material

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