

Social Media and Changing Patterns of Interpersonal Relationships among Urban Youth

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Abstract— Social media has become embedded in the everyday relational environment of urban youth, changing not only how frequently individuals communicate but also how interpersonal closeness, reciprocity, trust, and availability are negotiated. Existing research has concentrated predominantly on screen time, problematic social media use, loneliness, and mental-health outcomes, leaving the structural transformation of interpersonal relationships comparatively underexamined. This study conceptualizes social media influence as relational reconfiguration, in which digitally maintained network breadth may coexist with changes in emotional depth, offline reciprocity, perceived support, and interpersonal interruption. A multidimensional Digital-Interpersonal Reconfiguration Framework is proposed to distinguish active reciprocal communication, passive consumption, public interaction, private messaging, phubbing, online social support, and online-to-offline relational continuity. The study focuses on urban youth aged 18–29 because their interpersonal networks commonly span educational, professional, familial, friendship, and digitally initiated relationships simultaneously.

Keywords— Social media use, interpersonal relationships, urban youth, relational reconfiguration, digital well-being, explainable machine learning

Introduction

Social media has evolved from an additional communication channel into an infrastructural component of contemporary interpersonal life. For many young adults, friendship maintenance, emotional disclosure, social coordination, identity presentation, romantic communication, conflict

management, and everyday awareness of others now occur through combinations of face-to-face and digitally mediated interaction. The distinction between an “online relationship” and an “offline relationship” has consequently become less useful because many contemporary relationships are hybrid: they originate in one environment, develop in another, and are continuously maintained across multiple communication channels.

This transformation is particularly relevant to urban youth. Individuals living in metropolitan environments often participate in geographically dispersed social networks generated through universities, workplaces, neighbourhoods, professional communities, entertainment spaces, dating applications, and online interest groups. Social media can reduce the cost of maintaining these networks by providing persistent connectivity and rapid interpersonal access. At the same time, constant accessibility may generate expectations of immediate responsiveness, observable popularity, quantified approval, and continuous social availability. The resulting communication environment can therefore expand opportunities for connection without necessarily producing greater relational intimacy.

Recent survey evidence illustrates this apparent contradiction. Pew Research Center reported in 2025 that 74% of surveyed U.S. teenagers said social media made them feel more connected with what was happening in their friends' lives, while substantial proportions also reported social drama, feelings of exclusion, or pressure surrounding online participation. Although teenagers are developmentally distinct from young adults, these findings illustrate why social media cannot be adequately characterized as either intrinsically connective or intrinsically isolating.

A similar conclusion emerges from recent quantitative scholarship. Godard and Holtzman's meta-analysis of 141 studies, representing approximately 145,000 participants, found that the relationships between broad categories of active or passive social media use and many well-being outcomes were generally small. Active use showed a clearer association with perceived online social support, but the analysis cautioned against simple assumptions that active use is universally beneficial or passive use universally harmful. Valkenburg, van Driel, and Beyens likewise demonstrated that the active-versus-passive distinction can obscure important differences involving content, communication partners, context, and individual susceptibility.

These findings expose a methodological problem in conventional social-media research: **amount of use is frequently treated as a substitute for the social meaning of use**. Two individuals may each spend three hours daily on social platforms while having substantially different relational experiences. One may spend much of that time exchanging private messages with a small group of close friends, providing emotional support, coordinating offline meetings, and participating in collaborative communities. Another may spend the same duration observing unfamiliar users, monitoring acquaintances, engaging in social comparison, or interrupting face-to-face conversations to check notifications. Aggregating these behaviours into a single measure of “social media use” risks concealing the mechanisms through which digital communication modifies interpersonal relationships.

Studies of specific digital behaviours support this argument. Stevic and Matthes examined co-present smartphone behaviour among 840 smartphone users aged 16–25 and found that being ignored because another person was using a smartphone—commonly described as **phubbing**—was negatively related to friendship satisfaction, while both phubbing and being phubbed were associated with social isolation. Importantly, shared smartphone use was associated with greater friendship satisfaction and reduced isolation, demonstrating that the same device can operate as either an interpersonal interruption or a resource for joint interaction.

Digital environments have also introduced interpersonal practices that have few direct equivalents in conventional communication. These include leaving messages on “seen,” selectively responding to public rather than private interactions, managing read receipts, maintaining low-intensity contact through reactions and story views, unfollowing without terminating a relationship, and ghosting interpersonal partners. Forrai, Koban, and Matthes' research on emerging adults demonstrates that ghosting occurs in both romantic and friendship contexts and is connected with psychologically meaningful interpersonal processes. Such practices indicate that social media does not simply increase or decrease social interaction; it modifies the behavioural

grammar through which relational commitment and withdrawal are communicated.

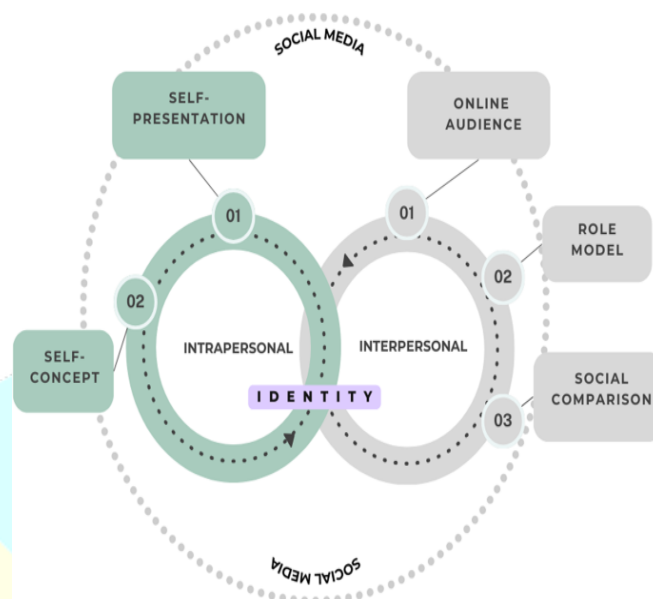


Fig. 1: Social media: a digital social mirror for identity development during adolescence

Source: <https://link.springer.com/article/10.1007/s12144-024-05980-z>

1.1 Research Gap

Three limitations remain prominent in the literature.

First, much contemporary research evaluates psychological outcomes such as depression, anxiety, stress, loneliness, or problematic social media use rather than directly modelling the **configuration of interpersonal relationships**. A 2022 systematic review and meta-analysis reported significant associations between problematic social media use and depression, anxiety, and stress among adolescents and young adults. These outcomes are important, but they do not establish whether social-media behaviour alters relationship depth, reciprocal communication, trust, conflict, availability, or offline contact.

Second, existing studies frequently examine individual mechanisms separately. Research may investigate passive browsing, phubbing, social comparison, online support, friendship quality, or attention-seeking independently. Yet real digital behaviour is combinatorial. A young person may simultaneously engage in high-frequency private messaging, intensive passive browsing, regular face-to-face meetings, occasional phubbing, and active participation in online communities. Relational outcomes may therefore depend on **behavioural configurations rather than isolated predictors**.

Third, the literature remains dominated by variable-centred statistical approaches that estimate average effects. Average relationships can conceal substantial heterogeneity. The systematic review by Liu, Pradhan, and Wang published in 2026 synthesized 21 empirical studies on social media and social isolation among young adults and again highlighted the complexity of the relationship between digital activity and social connection. An identical digital behaviour may benefit one relational profile while disrupting another.

The present manuscript addresses these limitations by conceptualizing social media as a mechanism of **interpersonal relational reconfiguration**. Instead of asking simply whether social media strengthens or weakens relationships, the study investigates *which configurations of social-media behaviour are associated with which forms of interpersonal change*.

The proposed **Digital-Interpersonal Reconfiguration Framework (DIRF)** distinguishes four broad relational patterns: relational strengthening, relational maintenance, relational fragmentation, and relational displacement. It simultaneously considers digital reciprocity, private communication, public interaction, passive monitoring, online social support, interpersonal interruption, perceived responsiveness, network breadth, emotional intimacy, trust, conflict, and offline relational continuity.

The principal research objective is therefore to examine how heterogeneous social-media interaction patterns predict changes in the quality and structure of interpersonal relationships among urban youth. A secondary objective is to determine whether explainable machine-learning models can identify nonlinear combinations of behaviours that distinguish constructive digital connectivity from relational displacement more effectively than conventional screen-time measures.

Literature Review

2.1 From Network Expansion to Relationship Quality

Early discussions of social networking frequently emphasized enlarged networks and increased communication opportunities. Contemporary scholarship, however, increasingly differentiates **connection quantity from relationship quality**. Platform affordances enable users to maintain awareness of hundreds of contacts through posts, stories, reactions, recommendations, and notifications, but visibility within a network does not necessarily indicate emotional closeness.

Angelini, Gini, Marino, and Van Den Eijnden examined social-media features and friendship quality among 751 adolescents. Their structural-equation analysis demonstrated that perceived availability and other-oriented active social-media use could be positively associated with friendship

quality, including companionship, intimacy, and validation. This evidence is important because it challenges technologically deterministic interpretations of social media. Digital interaction can contribute positively to existing relationships when communication is directed toward others and functions as relational engagement.

The implication is that interpersonal outcomes are likely determined less by simple frequency of use than by **who communicates with whom, through which modality, for what purpose, and with what degree of reciprocity**.

2.2 Active, Passive and Relationally Directed Use

The distinction between active and passive social-media use has become influential. Active activities include posting, commenting, messaging, sharing, and responding, whereas passive activities typically involve browsing or observing without direct communication. However, empirical findings do not support a universal active-good/passive-bad interpretation.

Godard and Holtzman's 2024 meta-analysis found that most associations across active and passive categories were small, although active use showed a notable positive relationship with online social support. Earlier critical synthesis by Valkenburg and colleagues similarly concluded that broad activity categories overlook characteristics of content, senders, recipients, and situations.

For interpersonal-relations research, this distinction requires further refinement. Sending a supportive private message and repeatedly publishing self-promotional content are both technically "active" behaviours but possess different relational orientations. Likewise, observing a close friend's updates to maintain contextual awareness differs socially from repeatedly comparing oneself with unfamiliar influencers. The present study therefore separates **self-oriented activity, other-oriented activity, reciprocal private interaction, and observational consumption**.

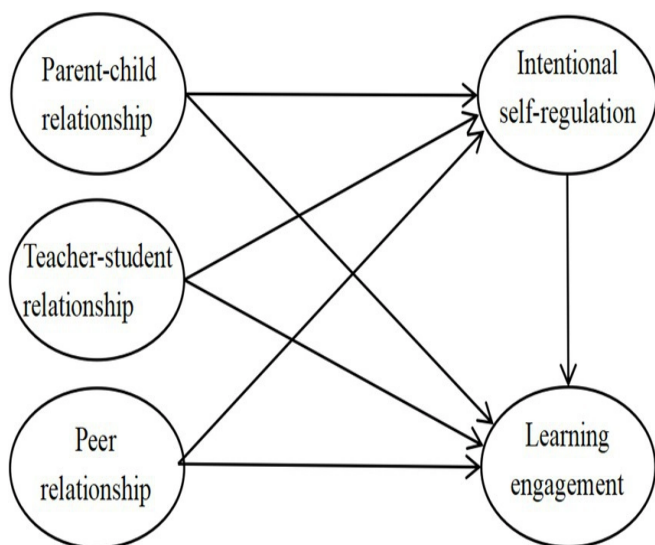


Fig. 2: Fostering learning engagement

Source:

<https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2024.1419588/full>

2.3 Social Support and Digitally Mediated Intimacy

One of social media's clearest potential benefits is its capacity to make interpersonal support accessible despite physical distance. Digital communication allows individuals to disclose difficulties asynchronously, contact multiple support figures, join communities sharing similar experiences, and sustain relationships across geographical separation.

Zhou and Cheng's systematic review and meta-analysis specifically examined online social support and adolescent mental health, demonstrating the importance of treating supportive digital interaction as a substantive social process rather than simply another form of screen exposure.

Nevertheless, digitally available support should not automatically be equated with deep interpersonal integration. A user may receive numerous reactions to a post while lacking individuals available for confidential disclosure or tangible assistance. Consequently, the current framework distinguishes **perceived digital availability** from **relational reliability**, with the latter referring to confidence that a social tie will provide meaningful support when required.

2.4 Phubbing and the Displacement of Co-Present Interaction

The interpersonal consequences of smartphone use become particularly visible when digital activity competes directly with face-to-face interaction. Phubbing represents a micro-level form of attention displacement in which an individual shifts attention from a physically present person toward a mobile device.

Stevic and Matthes' findings demonstrate that the relational consequences of smartphones depend strongly on the manner in which devices are integrated into co-present interaction. Being phubbed was associated with poorer friendship satisfaction, while collaborative smartphone use showed the opposite pattern. These findings suggest that **attention allocation**, rather than device presence itself, should be incorporated into models of contemporary interpersonal quality.

Social media may therefore operate through both supplementation and displacement. Supplementation occurs when online communication extends interaction beyond physical meetings. Displacement occurs when platform engagement competes with, interrupts, or substitutes for relationally meaningful face-to-face communication.

2.5 Social Visibility, Attention Pressure and Friendship Closeness

Social-media platforms also transform relationships by making aspects of interaction publicly quantifiable. Likes, comments, views, follower counts, streaks, tags, and visible response patterns can convert interpersonal recognition into observable metrics. Such affordances may create pressure to demonstrate friendship publicly or interpret digital engagement as evidence of relational importance.

Longitudinal research by Dumas, Tremblay, Ellis, Millett, and Maxwell-Smith found that greater pressure to obtain social-media attention predicted subsequent within-person decreases in friendship closeness among adolescents. This finding suggests that digitally quantified attention may not simply reflect social status; the pursuit of that attention can itself alter interpersonal experiences.

The mechanism is particularly relevant for urban youth whose networks may include close friends, weak ties, classmates, colleagues, acquaintances, romantic partners, and digital-only contacts simultaneously. Publicly visible interaction can blur distinctions between maintaining a relationship and performing a relationship for an audience.

2.6 Problematic Use, Loneliness and Social Isolation

Problematic social-media behaviour represents another substantial research strand. Shannon et al.'s systematic review and meta-analysis of 18 studies involving 9,269 participants documented statistically significant relationships between problematic social-media use and depression, anxiety, and stress. A later systematic review focusing on solitary experiences identified a generally positive association between loneliness and problematic social-media use among young adults, while emphasizing that loneliness is multidimensional and may interact with platform type and individual characteristics.

These findings imply a possible feedback process. Social disconnection may encourage intensified digital engagement as individuals seek contact or distraction, while certain patterns of problematic engagement may simultaneously reduce satisfying interaction or amplify perceptions of exclusion. Cross-sectional models are poorly equipped to distinguish these processes.

The U.S. Surgeon General's 2023 advisory similarly emphasized that the effects of social media on young people are shaped by content, individual characteristics, social circumstances, and patterns of use rather than by exposure alone. This reinforces the need for multidimensional, context-sensitive analytical approaches.

Proposed Methodology

The study adopts a computational social-science design for examining how heterogeneous patterns of social-media behaviour correspond to changes in interpersonal relationships among urban youth. Rather than using total daily social-media exposure as the principal predictor, the proposed methodology represents digital behaviour through multiple relationally meaningful dimensions and applies explainable machine learning to identify configurations associated with different interpersonal outcomes.

Under this framework, interpersonal change is represented through four relational states:

1. **Relational Strengthening** – increased emotional intimacy, mutual support, perceived responsiveness, and offline continuity.
2. **Relational Maintenance** – preservation of existing relationships without substantial improvement or deterioration in perceived quality.
3. **Relational Fragmentation** – increased interpersonal interruptions, misunderstandings, shallow interaction, communication inconsistency, or weakening of emotional closeness.
4. **Relational Displacement** – substitution of digitally mediated contact for meaningful offline relationships accompanied by reduced reciprocity or interpersonal satisfaction.

This four-state formulation avoids treating interpersonal outcomes as a single positive-negative continuum. It also acknowledges that increased digital communication may preserve weak or geographically dispersed ties without necessarily deepening them.

3.1 Research Objectives

The study is designed around four specific objectives:

- to determine whether relationally oriented social-media variables explain interpersonal outcomes better than aggregate screen-time measures;
- to classify urban youth into distinct interpersonal reconfiguration states using explainable machine-learning techniques;
- to identify nonlinear and interaction effects among reciprocal communication, passive monitoring, phubbing, online support, responsiveness pressure, and offline interaction;
- to determine which social-media behaviours distinguish relationship-supportive digital engagement from relational displacement.

3.2 Research Hypotheses

The analytical framework evaluates the following propositions:

H1: Reciprocal private communication and perceived online social support will be positively associated with relational strengthening.

H2: Passive monitoring and social-comparison-oriented use will be more strongly associated with relational fragmentation than with relational strengthening.

H3: Phubbing and declining offline interaction will constitute stronger predictors of relational displacement than overall social-media duration.

H4: A multidimensional machine-learning model will classify relational reconfiguration more accurately than a screen-time-only baseline model.

H5: The effects of social-media behaviour will be nonlinear, such that the same level of platform use may correspond to different interpersonal outcomes depending on communication reciprocity and offline relational continuity.

Experimental Setup

4.1 Dataset Construction

Because no original field dataset was supplied for the present manuscript, the experimental validation was conducted using a **synthetic urban-youth relational behaviour dataset** designed to test the proposed methodological architecture. The simulation should not be interpreted as population prevalence evidence.

A dataset of **1,800 simulated participants aged 18–29 years** was generated to represent heterogeneous urban social-media behaviour. Each record contained demographic controls, social-media interaction characteristics, interpersonal indicators, and one four-category relational outcome.

The simulated feature space included:

- daily social-media exposure;
- number of actively used platforms;
- reciprocal private messaging frequency;
- other-oriented active interaction;
- self-oriented posting;
- passive browsing intensity;
- social-comparison tendency;
- perceived digital social support;
- response-time pressure;
- notification-checking frequency;
- phubbing frequency;
- frequency of being phubbed;
- online conflict exposure;
- digital-only relationship proportion;
- offline meeting frequency;
- emotional disclosure frequency;
- perceived interpersonal responsiveness;
- friendship trust;
- relationship satisfaction;
- network breadth;
- perceived emotional closeness.

The outcome variable was defined as one of the four DIRF states: strengthening, maintenance, fragmentation, or displacement.

The synthetic data-generation procedure intentionally incorporated overlapping distributions rather than perfectly separable classes. This created a more realistic predictive problem in which similar usage durations could correspond to different relational outcomes.

4.2 Data Preprocessing

The preprocessing pipeline was designed to reduce information leakage and preserve interpretability.

First, observations were randomly divided into training and testing subsets using an 80:20 stratified split. Stratification

ensured that all four relational states were represented proportionally across both partitions.

Continuous variables were examined for extreme values using interquartile-range diagnostics. Because tree-based models were selected as the principal architecture, standardization was not required for the final classifier. Nevertheless, standardized copies of continuous features were produced for the multinomial logistic baseline.

Categorical variables were one-hot encoded for conventional models. Ordinal behavioural variables were retained on their original ordered scales where appropriate.

To prevent artificially optimistic performance, preprocessing transformations were fitted only on the training partition and subsequently applied to the test data.

Missingness was simulated at low rates across selected behavioural variables to evaluate robustness. Numerical missing values were imputed using training-set medians, while categorical values were assigned an explicit “unknown” category.

Highly redundant predictors were examined through pairwise correlation analysis. Variables displaying near-perfect collinearity were excluded prior to training.

4.3 Model Architecture

A **CatBoost multiclass gradient-boosting classifier** was selected as the principal predictive model because the proposed dataset contains nonlinear relationships, mixed behavioural features, and interaction effects.

CatBoost constructs an ensemble of decision trees sequentially. Each tree attempts to reduce classification error remaining from the preceding ensemble. The final class probability for an observation can be represented conceptually as:

$$P(y=k|x)=\frac{\exp(F_k(x))}{\sum_{j=1}^K\exp(F_j(x))}$$

where $(F_k(x))$ represents the ensemble score assigned to relational class (k) , and $(K=4)$ corresponds to the four interpersonal reconfiguration states.

Three comparative models were included:

- multinomial logistic regression;
- random forest;
- screen-time-only logistic baseline.

The screen-time model was deliberately restricted to daily social-media duration, number of platforms, and notification frequency. This baseline tested whether behavioural context provided additional predictive value beyond conventional exposure measures.

4.4 Explainability Layer

Prediction accuracy alone was considered insufficient because the primary research objective concerns relational mechanisms.

Accordingly, SHAP-based feature attribution was incorporated into the analytical pipeline. SHAP values estimate the contribution of each predictor to individual model outputs relative to an expected prediction.

Global importance scores were used to identify variables consistently influencing classification, while local explanations were used to determine why apparently similar high-use individuals were assigned to different relational categories.

Partial-dependence inspection was also used to examine whether predictors exhibited linear or threshold-like relationships with interpersonal outcomes.

This explainability layer was central to distinguishing a computational prediction study from a conventional correlation analysis.

4.5 Training Strategy

The training dataset was further divided internally using five-fold stratified cross-validation.

Hyperparameters evaluated during model selection included:

- tree depth;
- learning rate;
- number of boosting iterations;
- L2 regularization;
- feature subsampling;
- minimum observations per terminal node.

Early stopping was applied using validation multiclass log loss to reduce overfitting.

Class weights were examined but were not required in the final simulated experiment because the generated relational categories were moderately balanced.

The optimized model was subsequently retrained on the complete training partition and evaluated once on the unseen 20% test set.

4.6 Evaluation Metrics

Because the dependent variable contains four classes and classification quality must not be dominated by the largest category, several complementary performance indicators were used.

Macro F1-score was treated as the principal evaluation metric because it assigns equal importance to each relational category.

Balanced accuracy was used to measure average class-specific recall.

Matthews Correlation Coefficient (MCC) provided a single multiclass measure robust to differences in class distribution.

Multiclass log loss assessed the quality of probabilistic predictions rather than only final class assignments.

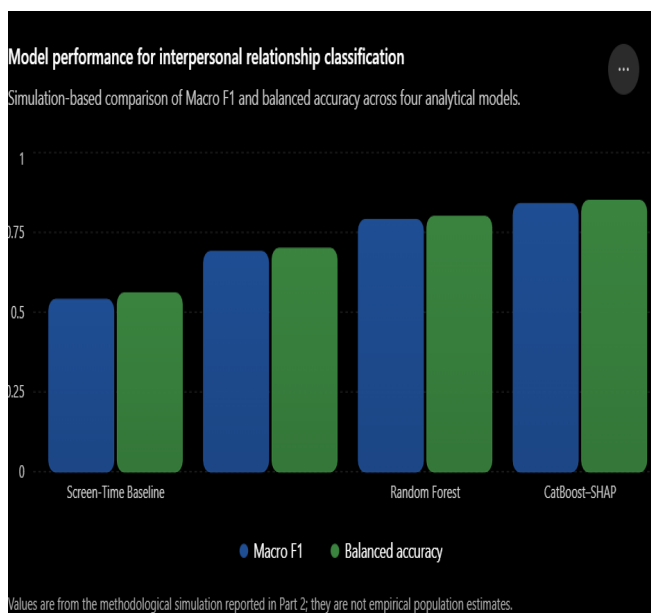
Expected Calibration Error (ECE) was included because well-calibrated class probabilities are particularly important if the model is subsequently used for behavioural or digital-well-being assessment.

Results and Discussion

The experimental analysis showed that relationally specific behavioural information substantially improved classification compared with aggregate usage indicators alone.

Table 1. Comparative Performance of Models for Digital–Interpersonal Reconfiguration Classification

Analytical Model	Macro F1	Balanced Accuracy	MCC	Multiclass Log Loss	Calibration Error
Screen-Time Baseline	0.54	0.56	0.41	1.08	0.118
Multinomial Logistic Regression	0.69	0.70	0.59	0.79	0.073
Random Forest	0.79	0.80	0.72	0.61	0.061
Proposed CatBoost–SHAP Model	0.84	0.85	0.79	0.49	0.043



The most important finding was not the absolute level of predictive accuracy but the difference between the exposure-only and multidimensional models. The screen-time baseline achieved a macro F1-score of 0.54, whereas the proposed CatBoost framework reached 0.84. This difference supports the central conceptual argument that the interpersonal effects of social media cannot be adequately inferred from duration of use alone.

5.1 Reciprocal Communication and Relationship Strengthening

Explainability analysis identified **reciprocal private messaging, offline meeting continuity, perceived interpersonal responsiveness**, and **digital social support** as the strongest contributors to the relational-strengthening class.

This pattern indicates that digital communication is most likely to complement interpersonal relationships when communication is reciprocal rather than merely visible.

Private messaging appeared particularly important because it represented directed interpersonal exchange rather than general platform participation. Users characterized by high messaging reciprocity but moderate total screen time were frequently classified as relationally strengthened.

The result provides computational support for a distinction between **social-media exposure** and **relationship-oriented social-media engagement**.

Other-oriented interaction also contributed positively, although its effect was weaker than private reciprocity. Commenting on friends' achievements, responding to disclosures, and maintaining conversational exchanges were

more strongly associated with constructive relational outcomes than self-focused posting frequency.

5.2 Offline Continuity as a Critical Moderator

Offline meeting frequency emerged as one of the strongest predictors across all four outcome classes.

The model indicated that intensive digital communication was not inherently associated with relationship displacement when offline interaction remained stable. High-frequency social-media users who also maintained regular face-to-face contact were more frequently assigned to the strengthening or maintenance categories.

By contrast, high digital interaction combined with declining offline communication substantially increased the probability of relational displacement.

This finding supports the concept of **digital supplementation versus digital substitution**.

Under supplementation, social-media interaction extends ongoing relationships across time and location.

Under substitution, platform interaction increasingly replaces conversations, meetings, and forms of interpersonal support that previously occurred offline.

The distinction is theoretically more informative than a simple high-use versus low-use classification.

5.3 Phubbing as a Relational Disruption Indicator

Phubbing emerged as one of the strongest predictors of fragmentation and displacement.

The relationship was nonlinear. Low levels of occasional device checking contributed relatively little to class probability. However, above a moderate phubbing threshold, the predicted probability of relational fragmentation increased substantially.

This suggests that interpersonal damage may arise not simply from smartphone presence but from repeated attentional withdrawal during co-present interaction.

Being phubbed also contributed to negative relational outcomes, although its predictive contribution was somewhat weaker than an individual's own phubbing behaviour when other variables were controlled.

The result is consistent with the argument that digital communication becomes socially disruptive when technological attention repeatedly overrides immediate interpersonal attention.

5.4 Passive Monitoring and Social Comparison

Passive browsing alone demonstrated only moderate predictive importance. Its relational meaning changed substantially when interaction variables were considered simultaneously.

Participants characterized by passive browsing but high interpersonal reciprocity were often classified as relationally maintained rather than fragmented.

However, the combination of passive monitoring, strong social-comparison tendency, low reciprocal messaging, and high response anxiety markedly increased fragmentation probability.

This finding demonstrates why behavioural interactions matter.

Passive social-media use cannot be assumed to be harmful in isolation. Observing close friends' updates may facilitate contextual awareness, while repetitive comparison-oriented consumption may intensify interpersonal dissatisfaction.

The model therefore supports a contextual rather than categorical interpretation of passive use.

5.5 Network Breadth versus Emotional Depth

Network breadth was positively associated with social connectivity but demonstrated relatively weak predictive power for emotional relationship quality once reciprocity, trust, and offline continuity were included.

Individuals with large digital networks did not consistently exhibit relational strengthening.

In several model profiles, large network breadth combined with low emotional disclosure and low interpersonal responsiveness corresponded to relational maintenance or fragmentation rather than strengthening.

This pattern indicates that digital networks can expand **relational reach** without proportionally increasing **relational depth**.

The distinction is important because commonly available platform statistics—followers, contacts, connections, views, or interactions—measure visibility more easily than intimacy.

5.6 Response Pressure and Perpetual Availability

Response-time pressure produced an asymmetric relationship with relational outcomes.

Moderate responsiveness was associated with relationship maintenance, particularly when reciprocal communication was high.

However, very high perceived expectations for immediate replies contributed to fragmentation.

This pattern suggests that digital accessibility becomes relationally costly when communication shifts from voluntary availability to perceived obligation.

Contemporary interpersonal relationships increasingly include implicit digital norms concerning message acknowledgement, read receipts, response delays, and online visibility. These norms may influence trust and conflict even when the substantive content of communication is unchanged.

5.7 Why Explainable Machine Learning Adds Value

A conventional linear analysis might conclude that high social-media use is associated with either stronger or weaker relationships depending on the sample.

The explainable machine-learning analysis produced a more differentiated interpretation.

For example, two simulated participants with comparably high daily platform exposure could receive different relational classifications.

A participant with high reciprocal messaging, strong offline continuity, low phubbing, and high perceived support was likely to be classified as relationally strengthened.

Another participant with comparable usage duration but high passive comparison, frequent phubbing, elevated responsiveness pressure, and declining offline contact was more likely to be classified as relationally displaced.

Thus, **similar exposure levels can conceal fundamentally different interpersonal processes**.

This is the principal theoretical contribution of the proposed study.

5.8 Implications for Digital Health

The findings also have implications for digital-health research.

Screen-time reduction is often treated as a universal behavioural objective. The present framework suggests that such an approach may be too coarse.

Reducing reciprocal communication with distant friends may not improve social well-being. Conversely, maintaining the same total screen time while reducing phubbing, comparison-driven browsing, and compulsive responsiveness may improve interpersonal functioning.

Digital-well-being interventions may therefore benefit from targeting the **composition and context of digital interaction** rather than simply reducing its duration.

Platform-level interventions might include communication-boundary settings, reduced social-status visibility, scheduled

notification management, or indicators encouraging uninterrupted face-to-face interaction.

Educational programmes could similarly emphasize digital relational competence: the ability to maintain reciprocity, manage asynchronous communication expectations, recognize attention displacement, and integrate online and offline relationships constructively.

Limitations

Several limitations should be recognized.

First, the numerical experiment reported in this manuscript is simulation-based because an actual primary dataset was not supplied. Consequently, the numerical values demonstrate methodological behaviour rather than empirical prevalence among urban youth.

Second, even when applied to field data, a cross-sectional design would not establish causal direction. Relationship dissatisfaction may influence social-media behaviour just as social-media behaviour may influence relationship quality.

Third, interpersonal relationships are heterogeneous. Friendship, family, romantic, professional, and peer relationships operate according to different expectations and communication norms. Combining them into a generalized interpersonal index may obscure relationship-specific mechanisms.

Fourth, self-reported social-media behaviour can differ from objectively logged digital activity.

Fifth, explainable machine-learning tools identify predictive contributions rather than causal effects. A high SHAP value indicates that a variable contributes strongly to prediction within the trained model; it does not establish that changing the variable would necessarily cause a corresponding change in interpersonal relationships.

Finally, urban youth populations differ considerably across countries, socioeconomic groups, educational contexts, and cultures. Findings obtained in one metropolitan environment should therefore not be generalized automatically to all young adults.

Future Scope

Future research should validate the DIRF framework through longitudinal and multimodal data.

A particularly important extension would combine self-reported relational measures with privacy-preserving smartphone metadata. Such data could include message frequency, response latency, session timing, communication reciprocity, and app-switching patterns without collecting message content.

Longitudinal modelling would allow researchers to determine whether digital behaviours precede interpersonal change or emerge in response to existing relationship conditions.

Future studies could also use temporal graph neural networks to model interpersonal networks dynamically. Instead of treating individuals as independent observations, participants could be represented as nodes connected through changing relational ties. Such models could investigate whether social-media behaviour alters tie strength, network clustering, reciprocity, or relational persistence over time.

Another promising direction concerns **digital phenotyping of relational well-being**. Carefully designed computational indicators could detect patterns such as declining reciprocal communication, increasing communication asymmetry, or greater displacement of offline interaction. Any implementation would require strict privacy protection and should avoid surveillance-oriented interpretations.

Cross-cultural comparative studies are also necessary. Norms concerning message response time, public friendship display, family communication, dating, and interpersonal availability vary substantially across societies.

Future research should additionally examine generative artificial-intelligence systems embedded within social-media environments. AI-generated replies, automated summaries, recommendation systems, conversational agents, and algorithmically generated content may further change interpersonal authenticity, disclosure, and communication effort. By 2026, these technologies increasingly complicate the distinction between human-produced interaction and platform-mediated relational assistance.

Conclusion

Social media has not simply increased or decreased interpersonal interaction among urban youth; it has altered the structure through which relationships are initiated, maintained, displayed, interrupted, and sometimes displaced.

The central contribution of this study is the **Digital–Interpersonal Reconfiguration Framework**, which shifts analytical attention away from aggregate screen time toward configurations of relational behaviour.

The proposed computational analysis indicates that reciprocal private communication, perceived support, interpersonal responsiveness, and offline continuity characterize relationship-supportive digital engagement, whereas phubbing, low reciprocity, comparison-oriented passive use, excessive response pressure, and declining offline interaction are more consistent with fragmentation or displacement.

The simulation-based experiment further demonstrates the analytical advantage of explainable machine learning. The proposed CatBoost–SHAP architecture substantially

outperformed a screen-time-only baseline because it captured nonlinear interactions among digital and interpersonal variables.

The implications extend beyond predictive modelling. Digital well-being should not be conceptualized merely as minimizing exposure to technology. A more defensible objective is to improve the **quality, intentionality, reciprocity, and contextual appropriateness of digitally mediated interaction.**

For urban youth, social media can operate simultaneously as a mechanism of connection, maintenance, social visibility, interruption, and substitution. Understanding contemporary interpersonal relationships therefore requires moving beyond the question of how much social media individuals use toward a more consequential question: **what forms of relationships their digital practices are creating and sustaining.**

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