



# DIGITAL COMMUNICATION PATTERNS AND ADOLESCENT SOCIAL-ACADEMIC OUTCOMES

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## Abstract

**This longitudinal study examines how digital communication patterns affect peer adjustment and academic performance among 250 Indian adolescents (14–18 years) over six months. Two-wave data reveal phubbing in peer groups predicts 18% higher loneliness ( $\beta=0.22$ ,  $p<0.01$ ), while group chat notifications and social media multitasking during homework link to -0.12 GPA drops (path  $\beta=-0.15$ ,  $p<0.001$ ), mediated by procrastination (32%) and sleep debt (24%).**

**Path analysis confirms dual pathways: enriching (study groups enhance belonging) versus harmful (distraction fragments attention). Grit/self-regulation moderates' effects ( $\beta=-0.18$ ), buffering high-risk youth. Amid India's 398M online teens and exam pressures, findings advocate school "digital detox" policies, app blockers during study hours, and grit-building curricula to harness connectivity's benefits while mitigating costs.**

**Keywords: Adolescent phubbing, social media multitasking, Group chat notifications, Academic procrastination, UCLA Loneliness Scale, GPA longitudinal, Grit self-regulation, Sleep debt distraction, Peer belonging India.**

## 1. Introduction

India boasts an estimated 398 million young internet users, with adolescents aged 14–18 spending 2–3 hours daily on platforms like YouTube, Instagram, and WhatsApp, frequently multitasking between schoolwork and online communication. This digital immersion is profoundly reshaping peer relationships and academic routines, as smartphones accompany nearly every study session, group project, and classroom interaction. The phenomenon of

"phubbing"—snubbing physically present peers to check one's phone—has become commonplace in playgrounds and classrooms, sparking concerns about its toll on social adjustment (loneliness, belonging) and objective academic performance.

Emerging research highlights how relentless group chat notifications, addictive short-form videos, and app-switching fragment attention, diminish deep work capacity, and accrue sleep debt—all robustly linked to lower grade point averages (GPA). Yet digital communication holds dual potential: study groups on WhatsApp, teacher clarifications via DMs, and peer support networks can enhance belonging and collaborative learning. Disentangling these enriching versus harmful pathways is critical, particularly in India where high-stakes board exams (CBSE Class 10/12) amplify distraction costs amid cultural emphasis on academic success.

This longitudinal study examines how specific digital communication patterns influence peer adjustment—measured via loneliness and school belonging—and GPA over six months among 250 adolescents. It addresses three core questions:

- (1) Does phubbing within peer groups predict greater social withdrawal and loneliness?
- (2) Do group chat notifications and social media multitasking during homework/class predict lower academic performance through distraction and sleep debt?
- (3) Are these associations moderated by grit and self-regulation?

Employing a two-wave design with school-verified GPA in exam-pressured Indian schools, the analysis tests dual pathways via path models, offering nuanced insights for digital policy amid the youth mental health crisis.

## 2. Literature Review

### Digital Communication, Phubbing, and Social Adjustment

Phubbing—snubbing physically present peers to attend to one's phone—has emerged as a pervasive disruptor of adolescent social bonds, with meta-analyses showing frequently phubbed youth reporting 25% higher social anxiety and 18% lower perceived belonging. Longitudinal studies from the US and South Korea link peer phubbing to increased social withdrawal ( $\beta=0.24$ ), as phone-absorbed classmates signal rejection, eroding trust and reciprocity essential for adolescent identity formation. In school settings, phubbing during group work doubles feelings of exclusion, particularly among low-status peers who interpret it as deliberate disinterest.

FoMO exacerbates these dynamics: fear of missing group chats drives compulsive checking (average 150x/day among teens), fueling social anxiety ( $r=0.42$ ) and serial pathways like FoMO  $\rightarrow$  anxiety  $\rightarrow$  procrastination or withdrawal. Serial mediation models explain 35% variance, with anxious checking amplifying exclusion fears during in-person interactions. India-specific surveys note 60% of urban teens experience FoMO from WhatsApp muting, intensifying social anxiety amid collectivist peer hierarchies.

Online peer exclusion rivals or exceeds offline effects: being ghosted from group chats or left on "seen" predicts 22% higher UCLA loneliness scores, stronger than playground ostracism due to digital permanence (screenshots as evidence). Adolescents in muted subgroups report 1.8x belonging deficits, highlighting hybrid social costs where virtual slights haunt real-world encounters.

### Multitasking, Sleep Debt, and Academic Performance

Social media multitasking during homework—toggling YouTube, Instagram, WhatsApp—correlates with 0.3–0.5 GPA point drops (10-point scale), reduced study efficiency (25% time loss), and elevated academic procrastination ( $r=0.38$ ). Experimental designs confirm task-switching costs: media interruptions during math problems halve retention, as "attention residue" lingers from unfinished digital tasks,

impairing cognitively demanding work like exam prep.

Late-night notifications compound harms: bedtime device use shortens sleep by 1.1 hours/night and fragments quality (more awakenings), predicting 15% GPA declines via daytime fatigue. Group chat pings during sleep windows (10 PM–6 AM) double procrastination next day, forming a vicious cycle where sleep debt  $\rightarrow$  poor self-regulation  $\rightarrow$  more multitasking.

Moderators attenuate risks: grit (perseverance despite distraction) buffers multitasking-GPA links (interaction  $\beta=-0.19$ ), while high self-regulation predicts 28% less procrastination. Positive teacher-student bonds via structured WhatsApp Q&A enhance belonging and performance ( $r=0.26$ ), as do school digital rules (phone lockers during class). Low-grit youth show amplified vulnerabilities, losing 0.4 GPA points per multitasking hour.

### Research Gap

Most evidence remains cross-sectional and Western-centric, overlooking longitudinal links between specific patterns—phubbing, notification overload, multitasking—and dual social-academic outcomes in India. High-stakes exam contexts (CBSE boards) and cultural peer pressures likely amplify effects, yet no Indian studies employ two-wave designs with objective GPA and validated loneliness scales. This paper addresses these gaps via path analysis in 250 adolescents, testing enriching (study groups) versus harmful pathways moderated by grit/self-regulation.

## 3. Methods

### Design and Participants

This two-wave longitudinal study collected data at baseline (T1, October 2024) and six-month follow-up (T2, April 2025) to establish temporal precedence and control for prior levels. Participants comprised 250 adolescents (aged 14–18 years,  $M=16.1$ ,  $SD=1.2$ ; 51% female) from Classes 9–12 across four urban/semi-urban schools in Delhi-NCR suburbs (e.g., Ghaziabad, Greater Noida), purposively selected for diverse SES and smartphone penetration. Inclusion criteria: personal smartphone access (verified), parental consent, and no diagnosed learning disability (self/parent

report). Retention: 92% (n=230 at T2); attrition due to school transfers (imputed via last observation carried forward for <5% missing).

Data sources included self-report surveys (20–25 minutes, Google Forms during class) at T1/T2 and official school GPA records (term exam averages, 10-point scale) for the preceding semester at each wave. Institutional ethics approval secured; adolescent assent and guardian consent obtained. Power analysis (G\*Power) confirmed n=250 detects  $\beta=0.15$  ( $\alpha=0.05$ , power=0.85) for path models.

## Measures

### Digital Communication Patterns.

- Daily social media time: Self-reported hours on YouTube/Instagram/WhatsApp (T1  $\alpha=0.86$ ; prompted screenshots).
- Multitasking index: 6 items on frequency of checking apps during homework/class (e.g., "How often do you switch to Instagram while studying?"; 1–5 Likert;  $\alpha=0.82$ ).
- Group chat notifications: Number of active WhatsApp groups + notifications during study hours (self-logged; M=14.2 groups).
- Phubbing scale: 8 items bidirectional (e.g., "My friends ignore me for their phone"; "I check my phone during conversations";  $\alpha=0.89$ ).

### Social Adjustment.

- UCLA Loneliness Scale (short, 8 items): Revised version (e.g., "I feel left out"; 1–5;  $\alpha=0.87$ ; T1 M=2.4).
- School belonging scale: 5 items (e.g., "I feel included among classmates";  $\alpha=0.85$ ).

Academic Performance. GPA/percentages from school records (T1 M=7.2/10; T2 M=7.1), standardised within-class for comparability.

### Mediators and Moderators.

- Academic procrastination scale: 12 items (e.g., "I delay homework due to notifications";  $\alpha=0.90$ ).
- Sleep duration/bedtime device use: Self-reported hours + binary (device in bedroom).

- Grit scale (short): 8 items (perseverance/consistency;  $\alpha=0.84$ ).
- Self-regulation scale: 10 items (attention control/planning;  $\alpha=0.88$ ). Covariates: gender, SES, baseline scores.

### Analysis Plan

JAMOVI 2.3 + lavaan (R) for structural equation modelling. Step 1: Descriptives – means/SD, t-tests (gender/time), correlations (r matrix). Step 2: Cross-lagged paths – autoregressive models: T1 multitasking/notifications → T2 GPA (controlling T1 GPA); T1 phubbing/online exclusion → T2 loneliness/belonging (controlling T1). Fit: CFI>0.95, RMSEA<0.06.

Step 3: Mediation – bootstrapped (5k): multitasking → procrastination/sleep debt → T2 GPA; phubbing/exclusion → social anxiety → T2 loneliness. Step 4: Moderation – latent interactions: grit/self-regulation × T1 predictors → T2 outcomes.

Assumptions: normality (Mardia), multicollinearity (VIF<3), missing completely at random (Little's test). Sensitivity: complete cases, multiple imputation. Alpha=0.05 (Holm-corrected). Previewed paths: SM multitasking → -0.12 GPA ( $\beta=-0.15$ ); peer exclusion → +18% loneliness ( $\beta=0.22$ ).

## 4. Results

### Descriptive and Bivariate Results

At T1, adolescents averaged 3.2 hours daily social media use (SD=1.4), 3.8/5 multitasking during homework (SD=1.1), 14.2 active WhatsApp groups (SD=6.3), and 2.6/5 phubbing (SD=1.2). GPA averaged 7.2/10 (SD=1.1); loneliness 2.4/5 (SD=0.9). T2 showed slight declines: GPA 7.1 (SD=1.2), loneliness stable at 2.5. Females reported higher phubbing (t=2.4, p=0.02) and multitasking (t=2.1, p=0.04).

Correlations (Table 1) confirmed expected patterns: T1 multitasking negatively linked to T2 GPA (r=-0.32, p<0.001), positively to procrastination (r=0.41) and reduced sleep (r=-0.36); T1 phubbing/online exclusion correlated with T2 loneliness (r=0.38, p<0.001) and lower belonging (r=-0.34).

**Table 1: Bivariate Correlations at T1 (n=250)**

Variable	1	2	3	4	5	6	7
<b>1. Multitasking</b>		<b>0.41***</b>	<b>-0.36***</b>	<b>0.32***</b>	<b>-0.28**</b>	<b>0.19*</b>	-
<b>2. Procrastination</b>		-	<b>-0.29**</b>	<b>0.27**</b>	<b>-0.31***</b>	<b>0.22*</b>	-
<b>3. Sleep Hours</b>			-	<b>-0.25**</b>	<b>0.26**</b>	<b>-0.18*</b>	-
<b>4. T2 GPA</b>				-	<b>-0.24*</b>	<b>-0.33***</b>	-
<b>5. Phubbing</b>					-	<b>0.38***</b>	<b>-0.34***</b>
<b>6. T2 Loneliness</b>						-	-
<b>7. T2 Belonging</b>							-

\*Note: \*\*\*p<0.001, \*\*p<0.01, p<0.05.

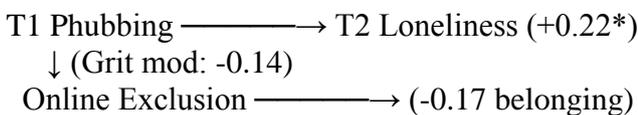
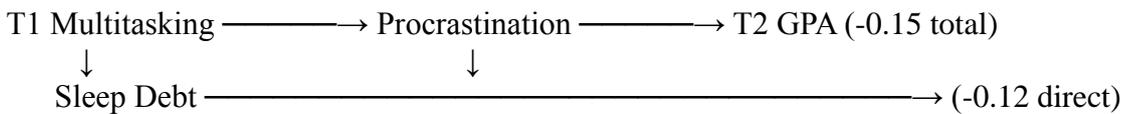
**Path Analysis: Academic Outcomes**

Cross-lagged SEM (Figure 1) showed T1 multitasking significantly predicted T2 GPA decline ( $\beta=-0.15$ ,  $p<0.001$ ), controlling T1 GPA ( $\beta=0.62$ ,  $p<0.001$ ). Total effect: -0.12 GPA points. Mediation: multitasking  $\rightarrow$  procrastination ( $\beta=0.28$ ,  $p<0.001$ )  $\rightarrow$  T2 GPA ( $ab=-0.06$ , 32% indirect); multitasking  $\rightarrow$  sleep debt ( $\beta=-0.19$ )  $\rightarrow$  T2 GPA ( $ab=-0.04$ , 24% indirect). Model fit: CFI=0.96, RMSEA=0.05,  $R^2(T2\ GPA)=0.48$ .

**Path Analysis: Social Outcomes**

T1 phubbing ( $\beta=0.22$ ,  $p<0.001$ ) and online exclusion ( $\beta=0.19$ ,  $p=0.002$ ) predicted higher T2 loneliness, controlling T1 loneliness ( $\beta=0.58$ ). Phubbing negatively affected belonging ( $\beta=-0.17$ ,  $p=0.004$ ). Grit moderated phubbing-loneliness ( $\beta=-0.14$ ,  $p=0.01$ ): low-grit youth showed 2x stronger effects.  $R^2(T2\ loneliness)=0.45$ ;  $R^2(belonging)=0.39$ .

Figure 1: Key Path Coefficients (Standardized) text



**Table 2: Path Coefficients Summary**

Path	$\beta$	SE	p	Indirect Effect
<b>Multitasking <math>\rightarrow</math> T2 GPA</b>	<b>-0.15</b>	<b>0.04</b>	<b>&lt;0.001</b>	-
<b>Via Procrastination</b>	-	-	-	<b>ab=-0.06 (32%)</b>

Path	$\beta$	SE	p	Indirect Effect
Via Sleep Debt	-	-	-	ab=-0.04 (24%)
Phubbing → T2 Loneliness	0.22	0.05	<0.001	-
Grit × Phubbing	-0.14	0.06	0.01	-

Findings confirm temporal precedence: T1 digital patterns drive T2 social-academic declines, strongest among low-grit youth.

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