Assessing Mental Health, Academic Performance and Behavioral Trends of College Students using Smartphones

Rui Wang, Fanglin Chen, Zhenyu Chen, Tianxing Li, Xia Zhou, Dror Ben-Zeev, Andrew T. Campbell (Dartmouth College), Gabriella Harari (University of Texas at Austin), Stefanie Tignor (Northeastern)
the stakeholders
much of the stress and strain of student life remains hidden
why do students burnout, drop classes, do poorly, even drop out of college when others excel?

what is the impact of stress, mood, workload, sociability, sleep and mental health on academic performance?

is there a set of behavioral trends or signature to the Dartmouth term
StudentLife study

48 students over 10 week Spring 2013 term
• 10 female, 38 male
• 30 undergraduates, 18 graduates
• 8 seniors, 14 juniors, 6 sophomores, 2 freshmen, 3 Ph.D students, 1 second-year Masters student, and 13 first-year Masters students
• 23 Caucasians, 23 Asians and 2 African-Americans.
sensing system
Android phone

accelerometer
microphone
light Sensor
GPS/Bluetooth

automatic continuous sensing

self-reports
SurveyMonkey
mobile EMA

behavioral classifiers
activity
conversation
sleep
location/co-location

statistical analysis
mental health
academic performance
behavioral term trends
management scripts

StudentLife cloud

cloud
classifiers
activity

sitting

standing

walking

running
around conversation

conservation duration and frequency

voiced
Activity Feature
- stationary duration

Sound Feature
- silence duration

Light Feature
- darkness duration

Phone Usage Features
- Phone-lock, charging, phone-off duration

Linear regression model

\[ Sl = \sum_{i=1}^{6} \alpha_i \cdot F_i, \quad \alpha_i \geq 0 \]

\[ \min_{\alpha_i} \sum_{j=1}^{4} (Sl^j - \sum_{i=1}^{6} \alpha_i \cdot F_i^j)^2 \]
we also computed

- activity duration
- outdoor mobility
- indoor mobility
- location and co-location
ecological momentary assessment (ema)
Touch how you feel right now.

Right now, I am...

- A little stressed
- Definitely stressed
- Stressed out
- Feeling good
- Feeling great

Save Response
mental health surveys
### PATIENT HEALTH QUESTIONNAIRE (PHQ-9)

**Name:**

**Date:**

Over the last 2 weeks, how often have you been bothered by any of the following problems?

*(use “✓” to indicate your answer)*

<table>
<thead>
<tr>
<th></th>
<th>Not at all</th>
<th>Several days</th>
<th>More than half the days</th>
<th>Nearly every day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Little interest or pleasure in doing things</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2. Feeling down, depressed, or hopeless</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3. Trouble falling or staying asleep, or sleeping too much</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4. Feeling tired or having little energy</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>5. Poor appetite or overeating</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>6. Feeling bad about yourself—or that you are a failure or have let yourself or your family down</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>7. Trouble concentrating on things, such as reading the newspaper or watching television</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>8. Moving or speaking so slowly that other people could have noticed. Or the opposite — being so fidgety or restless that you have been moving around a lot more than usual</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>9. Thoughts that you would be better off dead, or of hurting yourself</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

---

**Depression Severity:***

<table>
<thead>
<tr>
<th>depression severity</th>
<th>minimal</th>
<th>minor</th>
<th>moderate</th>
<th>moderately severe</th>
<th>severe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1-4</td>
<td>5-9</td>
<td>10-14</td>
<td>15-19</td>
<td>20-27</td>
</tr>
</tbody>
</table>

**Number of Students (Pre-survey):***

|                      | 17      | 15     | 6        | 1      | 1      |

**Number of Students (Post-survey):***

|                      | 19      | 12     | 3        | 2      | 2      |
pre-post questionnaires

- depression scale
- perceived stress scale
- loneliness scale
- flourishing scale
mental health
depression

Sleep duration *
Conversation frequency (day) **
Conversation frequency (evening) *
Number of co-locations *

*p ≤ 0.05, **p ≤ 0.01
loneliness

- activity duration *
- activity duration (evening) **
- traveled distance (day) *
- Indoor mobility (day) *

*R value

*p ≤ 0.05, **p ≤ 0.01
academic performance
spring GPA

- conversation duration (day)
- conversation frequency (day)
- indoor mobility during (day)
- indoor mobility during (night)

p ≤ 0.05
behavioral trends
conversation

number of deadlines

mid-term
time spent in dorms

- **deadlines**
  - Indorm
- **time spent in dorms**
- **reading**
- **day**
  - 1, 8, 15, 22, 29, 36, 43, 50, 57, 64

Mid-term
gym visits

- Reading
- Deadlines
- Gym visits

mid-term
stress and affect

mid-term

deadlines

positive affect (PA)

stress
class attendance

[Graph showing the number of deadlines and attendance over days, with a shaded area labeled 'mid-term']
why are these results important?
because we find significant correlations between objective sensor data from smartphones and outcomes from validated mental health “gold standard” surveys
back to the stakeholders
StudentLife is the first study that uses passive and automatic sensing data from the phones of a class of 48 Dartmouth College students over a term to assess their mental health (e.g., depression, loneliness, stress), academic performance (grades across all the classes and cumulative GPA) and behavioral trends (e.g., how stress, sleep, visits to the gym, etc. change in response to college life).
Big thanks

Ethan Berke (DHMC)
Tanzeem Choudhury (Cornell)
Randy Colvin (Northeastern)
Sam Gosling (UT Austin)
Catherine Norris (Swarthmore)