Adolescents’ Use and Perceived Usefulness of Mobile Technology for Meeting their Health Information Needs and Improving Adherence to Improved Health Behaviors

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Overview of mHealth

• Ubiquitous nature of mobile technologies in daily life (e.g., smart phones, sensors) has created opportunities for applications that were not previously possible

• To support care delivery through:
  • meeting information
  • Communication
  • documentation needs of clinicians, patients, and other healthcare workers
  • facilitates health resource monitoring and management
Purpose

• Usability:
  • To understand the usability factors and evaluation strategies for mobile health technology (mHealth)

• Information Needs:
  • To conduct formative research to understand adolescents health information needs in real-time
  • To assess adolescents’ use of mHealth technology for meeting their health information needs
3 Small Studies

1. A Comparison of Usability Factors of Four Mobile Devices for Accessing Healthcare Information by Adolescents

2. Health Information Seeking Behaviors of Ethnically Diverse Adolescents – Focus Groups

3. Using SMS Text Messaging to Assess Adolescents' Health Information Needs in Real Time: An Ecological Momentary Assessment
A comparison of usability factors of four mobile devices for accessing healthcare information by adolescents

Examined the usability of 4 commonly used mobile devices:

1) iPhone
2) an Android with touchscreen keyboard
3) an Android with built-in keyboard
4) iPad

Procedures

Sample: 18 Urban Minority Adolescents

• A think-aloud protocol

• 5 tasks:
  • 2 tasks - accessing health information via a website using the mobile device’s web-browser
    • AIDS Healthcare Foundation and Medline Plus
  • 2 tasks - using health-related mobile applications
    • MyfitnessPal and Sparkpeople Diet Tracker
  • 1 task - calendar

Analysis

Guided by the FITT framework
- Fit between Individuals, Task, and Technology

1) Task-technology fit
2) Individual-technology fit
3) Individual-task fit.

## Results

<table>
<thead>
<tr>
<th>Measure</th>
<th>iPhone (n=10)</th>
<th>iPad (n=9)</th>
<th>Android Impulse (n=9)</th>
<th>Android Keyboard (n=10)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task steps</td>
<td>51.80</td>
<td>53.89</td>
<td>57.00</td>
<td>60.70</td>
<td>0.708</td>
</tr>
<tr>
<td>Task time</td>
<td>7.50</td>
<td>9.89</td>
<td>10.67</td>
<td>11.50</td>
<td>0.049</td>
</tr>
<tr>
<td>Errors/prompts</td>
<td>4.30</td>
<td>8.78</td>
<td>8.78</td>
<td>6.80</td>
<td>0.298</td>
</tr>
</tbody>
</table>

# Results

<table>
<thead>
<tr>
<th>PSSUQ scale</th>
<th>iPad</th>
<th>iPhone</th>
<th>Android impulse</th>
<th>Android Keyboard</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Usefulness</td>
<td>1.8</td>
<td>2.3</td>
<td>2.9</td>
<td>3.2</td>
<td>0.19</td>
</tr>
<tr>
<td>Information Quality</td>
<td>1.9</td>
<td>2.6</td>
<td>2.8</td>
<td>3.4</td>
<td>0.16</td>
</tr>
<tr>
<td>Interface Quality</td>
<td>2.6</td>
<td>2.2</td>
<td>2.0</td>
<td>3.7</td>
<td>0.02</td>
</tr>
<tr>
<td>Overall Satisfaction</td>
<td>1.8</td>
<td>2.4</td>
<td>2.7</td>
<td>3.4</td>
<td>0.11</td>
</tr>
</tbody>
</table>

Conclusions

• All of our users were able to complete all of the tasks.
• The time needed to complete the tasks was significantly different by:
  • mobile device
  • mHealth application

• Interface Quality
Usability Evaluation Frameworks

• Theoretical frameworks/models are essential to research studies!

• There are few evaluation frameworks for assessing the usability of mHealth

• Frameworks: TAM, TAM 2, TRA, TPB, C TAM-TPB, UTAUT, Motivational Model, Information System Success Model…

• (For more see: http://cumc.columbia.edu/dept/nursing/ebp/usaEval/TMframework1.html)
Health IT Usability Evaluation Model (Health- ITUEM)
<table>
<thead>
<tr>
<th>Description</th>
<th>System offers error management, such as error messages as feedback, error correction through undo function, or error prevention, such as instructions or reminders, to assist users performing tasks.</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ Error prevention</td>
<td>Positive occurrence or response related to Parent Code Error prevention</td>
</tr>
<tr>
<td>- Error prevention</td>
<td>Negative occurrence or response related to Parent Code Error prevention</td>
</tr>
<tr>
<td>Completeness</td>
<td>System is able to assist users to successfully complete tasks. This is usually measured objectively by system log files for completion rate.</td>
</tr>
<tr>
<td>+ Completeness</td>
<td>Positive occurrence or response related to Parent Code Completeness</td>
</tr>
<tr>
<td>- Completeness</td>
<td>Negative occurrence or response related to Parent Code Completeness</td>
</tr>
<tr>
<td>Memorability</td>
<td>Users can remember easily how to perform tasks through the system.</td>
</tr>
<tr>
<td>+ Memorability</td>
<td>Positive occurrence or response related to Parent Code Memorability</td>
</tr>
<tr>
<td>- Memorability</td>
<td>Negative occurrence or response related to Parent Code Memorability</td>
</tr>
<tr>
<td>Information needs</td>
<td>The information content offered by the system for basic task performance, or to improve task performance.</td>
</tr>
<tr>
<td>+ Information needs</td>
<td>Positive occurrence or response related to Parent Code Information needs</td>
</tr>
<tr>
<td>- Information needs</td>
<td>Negative occurrence or response related to Parent Code Information needs</td>
</tr>
<tr>
<td>Flexibility/Customizability</td>
<td>System provides more than one way to accomplish tasks, which allows users to operate system as preferred.</td>
</tr>
<tr>
<td>Flexibility/Customizability</td>
<td>Positive occurrence or response related to Parent Code Flexibility/Customizability</td>
</tr>
<tr>
<td>- Flexibility/Customizability</td>
<td>Negative occurrence or response related to Parent Code Flexibility/Customizability</td>
</tr>
<tr>
<td>Learnability</td>
<td>Users are able to easily learn how to operate the system.</td>
</tr>
<tr>
<td>+ Learnability</td>
<td>Positive occurrence or response related to Parent Code Learnability</td>
</tr>
<tr>
<td>- Learnability</td>
<td>Negative occurrence or response related to Parent Code Learnability</td>
</tr>
<tr>
<td>Performance speed</td>
<td>Users are able use the system efficiently.</td>
</tr>
<tr>
<td>+ Performance speed</td>
<td>Positive occurrence or response related to Parent Code Performance speed</td>
</tr>
<tr>
<td>- Performance speed</td>
<td>Negative occurrence or response related to Parent Code Performance speed</td>
</tr>
<tr>
<td>Competency</td>
<td>Users are confident in their ability to perform tasks using the system, based on Social Cognitive Theory.</td>
</tr>
<tr>
<td>- Competency</td>
<td>Negative occurrence or response related to Parent Code Competency</td>
</tr>
<tr>
<td>+ Competency</td>
<td>Positive occurrence or response related to Parent Code Competency</td>
</tr>
<tr>
<td>Other system-specific expected outcomes</td>
<td>Other system-specific expected outcomes representing higher level of expectations. (uses of non- continued</td>
</tr>
</tbody>
</table>
Procedures

• 2 Exemplars:
  - Focus Group Sessions with Adolescents.
    - 6 focus group sessions to explore adolescents' use of mobile technology for meeting their health information needs
    - 4 focus group sessions following an EMA study with pre-installed health-related apps
Results

![Diagram of mHealth IT Usability factors]

- **Subjective**
  - Satisfaction
    - Perceived Ease of Use
      - Error prevention 7 (100%)
      - Other outcomes 111 (93%)
      - Information needs 98 (91%)
      - Memorability 1 (100%)
    - Learnability 22 (88%)
    - Competency 11 (95%)
    - Perform speed 115 (87%)
    - Flexibility/Customizability 18 (66%)
  - Perceived Usefulness
    - Efficiency
    - Effectiveness

The frequency of code use in exemplars is denoted by $f$ (IRR%), indicating percent inter-rater reliability.
Frequency of Code Use in Exemplars

Results/ Conclusions

• Performance speed, Information needs and Other outcomes
  - most frequently used codes across both exemplars.

• Memorability and error prevention – ARE THEY APPLICABLE TO mHealth?
Understanding Adolescents Health Information Needs through the Use of Mobile Technology
Background

• The number of adolescents in the U.S. began to increase in the 1990s and is expected to keep increasing through 2050.
• From 1990 to 2000, the adolescent population increased by 16.6%, from 34.9 million to 40.7 million.
• The adolescent population is more racially/ethnically diverse than the general population.
Background

• Black adolescents under age 18 experience poverty more than their same age peers in other racial/ethnic groups

• Hispanic youths had the second highest poverty rate

• Adolescents are particularly at risk of being uninsured

• The association between poverty, health status, race, ethnicity, insurance status, geographic location, and access to good quality health care, or any health care, is well documented

• Health Issues:
  – Asthma
  – Obesity
  – HIV

• Behaviors and decision-making processes learned and habituated at a young age are likely to be more sustainable over time
Purpose

• To conduct formative research to understand adolescents health information needs in real-time

• To assess adolescents’ use of mHealth technology for meeting their information needs

Methods

- Demographic Surveys
- Ecological Momentary Assessment (EMA)
- Follow-up Focus Groups
Sample

- 60 adolescents
  - 37 Male, 22 Female
  - 42 Hispanic, 14 Non-Hispanic
  - 1 AI/AN, 16 Black, 5 PI, 1 White, 7 Multi-racial,
  - 27 Other, 1 Decline to State
- 63.3% Use Computer several times everyday
- 90.0% Started using computer more than 2 years ago
- 76.7% Use mobile device several times every day
- 28 Android Phone, 17 iPhone, 2 WebOs, 1 Tablet
<table>
<thead>
<tr>
<th>Item</th>
<th># of Items</th>
<th>Definition</th>
<th>Adolescent Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Functioning</td>
<td>10</td>
<td>Performs all types of physical activities including the most vigorous without limitations due to health</td>
<td>46.9 (20.4)</td>
</tr>
<tr>
<td>Physical Health</td>
<td>4</td>
<td>No problems with work or other daily activities</td>
<td>83.8 (20.5)</td>
</tr>
<tr>
<td>Emotional Problems</td>
<td>3</td>
<td>Feels peaceful, happy, and calm all of the time</td>
<td>76.4 (34.5)</td>
</tr>
<tr>
<td>Energy Fatigue</td>
<td>4</td>
<td>Feels full of pep and energy all of the time</td>
<td>72.3 (14.3)</td>
</tr>
<tr>
<td>Emotional Well-being</td>
<td>5</td>
<td>No problems with work or other daily activities</td>
<td>78.0 (16.1)</td>
</tr>
<tr>
<td>Social Functioning</td>
<td>2</td>
<td>Performs normal social activities without interference due to physical or emotional problems</td>
<td>60.4 (27.4)</td>
</tr>
<tr>
<td>Pain</td>
<td>2</td>
<td>No pain or limitations due to pain</td>
<td>49.3 (33.7)</td>
</tr>
<tr>
<td>General Health</td>
<td>5</td>
<td>Evaluates personal health as excellent</td>
<td>70.3 (19.9)</td>
</tr>
</tbody>
</table>
Methods

• Each participant received a smartphone with unlimited text messages (TM) and data access, as well as 600 voice minutes for 30 days

• Each Smartphone had applications related to asthma, obesity, HIV and diet preinstalled on the phone
Pre-loaded Apps on Smartphones
Procedure - EMA

We used a hosted messaging gateway service to send TM three times per week to ask adolescents the following questions:

1) What question did you have about your health today?
2) Where did you look for an answer (mobile device, app, online, friend, book, parent)?
3) Was your question answered and how?
4) Anything else?
Data Analysis - EMA

• Two team members independently coded each of the text message responses

• After coding was completed, the authors met and discussed any discrepancies in their coding
Findings - EMA

• Text Sent
• Data Used
• Minutes Used
# Telephone Service Used (30 days)

<table>
<thead>
<tr>
<th></th>
<th>Mean (S.D.)</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text</td>
<td>2,514 (2,751)</td>
<td>50</td>
<td>12,474</td>
</tr>
<tr>
<td>Data (mb)</td>
<td>4,848,708 (5,938,819)</td>
<td>33,461</td>
<td>28,235,106</td>
</tr>
<tr>
<td>Minutes</td>
<td>743 (1,045)</td>
<td>0</td>
<td>4,436</td>
</tr>
</tbody>
</table>
Findings - EMA

• Adolescents sent 1935 text messages over the study period.
• 624 text messages could not be coded because they were irrelevant or provided too little detail to be well-understood.
• Adolescents sent a total of 421 text messages related to a health information needs.
EMA - Results

1935 Total Text Messages

624 Text messages could not be coded

EMA Questions:
1. What question did you have about your health today?
421 Text messages Health Information Needs (Table 2)
2. Where did you look for an answer?
516 Text messages Information Sources (Table 3)
3. Was your question answered and how?
42 Text messages: No
332 Text messages: Yes
EMA - Results

• Adolescents sent 516 text messages related to the source of information to answer their question

• The most common source of information was online (N=200)
  – Google – 48 (24%)

• Source of information was for answering their question:
  – Parents, Family (included siblings, aunt, uncle), teacher/coach, Book, online, mobile device and mobile app
<table>
<thead>
<tr>
<th>Source of Health Information</th>
<th>Type</th>
<th>Total N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>Parent</td>
<td>101</td>
<td></td>
</tr>
<tr>
<td>Friend</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>Mobile device/app</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Teacher/Coach</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Doctor</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Family</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

- It was answers by online using a search site like Google.
- Yes and by a medical Q&A website.
- Doctor told me this.
- I asked my mom.
- It was answer by my step father showing me different way to do it.
- I asked around to my friends.
- I found answers on the information app on the phone.
- I got the idea from my gym teacher.
- I asked my sister for an answer.
EMA - Results

• 332 of their questions were answered
• 42 were not answered
• Participants did not provide a response to this question for every health information need that they reported
Procedure – Focus Groups

• Following 30 days of mobile phone use

• Focus groups were held in a conference room at the Columbia University School of Nursing.

• Pizza and drinks were served

• $20 Compensation

• We had a total of 4 sessions with 37 participants across all sessions
Findings - Focus Group

Use of their mobile phones for:

- music
- calendar/ alarm
- text messaging
- Games
- Navigation
- Camera
- Google, Facebook and YouTube

“If I have any health-related problems I usually just go on Google and it takes to me some doctor website, where real doctors answer the questions”
Findings – Focus Group

Usability Factors:

– Readability
  • “They kept using big words.”
  • “dumb everything down.”

– User Interface
  • “The ones that looks cooler.”
  • “It’s just the way it looks, like it was boring.”
Findings

Privacy

– codes on their phone

• “I want my stuff to be protected, like I don’t know who is going to go into my phone and do what with it
• “I don’t want my mom to see my messages.”
• “I don’t want anybody touching my stuff,” and the code would discourage others from using his phone.
Findings

Security

– Concerns
– “I felt like there was a person sitting on a computer watching me.”
– “People don’t like being watched.”
– “I thought that they were looking at our messages and stuff.”
Discussion

• Adolescents have many health information needs
  - many of these go unanswered
• Diet/ Exercise if the most frequent health information need of adolescents
• Tailoring applications and programs for adolescents is critical
Acknowledgments

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