DIGITAL DIVIDE 3.0: THE MOBILE REVOLUTION, SMARTPHONE USE, AND THE
EMERGING DEVICE GAP

by

Eric Tsetsi

Copyright © Eric Tsetsi 2016

A Thesis Submitted to the Faculty of the

DEPARTMENT OF COMMUNICATION

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF ARTS

In the Graduate College

THE UNIVERSITY OF ARIZONA

2016
STATEMENT BY AUTHOR

The thesis titled *Digital Divide 3.0: The Mobile Revolution, Smartphone Use, and the Emerging Device Gap* prepared by *Eric Tsetsi* has been submitted in partial fulfillment of requirements for a master’s degree at the University of Arizona and is deposited in the University Library to be made available to borrowers under rules of the Library.

Brief quotations from this thesis are allowable without special permission, provided that an accurate acknowledgement of the source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the Graduate College when in his or her judgment the proposed use of the material is in the interests of scholarship. In all other instances, however, permission must be obtained from the author.

SIGNED: *Eric Tsetsi*

APPROVAL BY THESIS DIRECTOR

This thesis has been approved on the date shown below:

<table>
<thead>
<tr>
<th>Stephen Rains, Ph.D.</th>
<th>5-12-16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thesis Director Name</td>
<td>Date</td>
</tr>
<tr>
<td>Associate Professor of Communication</td>
<td></td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Abstract</td>
<td>4</td>
</tr>
<tr>
<td>Introduction</td>
<td>5</td>
</tr>
<tr>
<td>Literature review</td>
<td>8</td>
</tr>
<tr>
<td>Hypotheses</td>
<td>15</td>
</tr>
<tr>
<td>Methods</td>
<td>22</td>
</tr>
<tr>
<td>Results</td>
<td>25</td>
</tr>
<tr>
<td>Discussion</td>
<td>52</td>
</tr>
<tr>
<td>References</td>
<td>61</td>
</tr>
</tbody>
</table>
Abstract

Digital divide research has recently begun to address the functional gaps between Internet-connected technologies, specifically mobile and wired devices. This study uses nationally representative survey data from the Pew Internet and American Life Project to address this area of research and explores how smartphone-dependence compared to multi-modal access impacts Internet use among key demographic groups including race, sex, age, income, and education. This study also explores how demographic characteristics and smartphone use interact to affect reliance on smartphones and perceptions of the utility of mobile devices. Results show that race, sex, age, income, and education, exhibit different rates of smartphone-dependence, and also perform different online activities with their smartphones. Minorities and younger users are more likely to be smartphone-dependent and multi-modal users suggesting that these demographic groups are adopting mobile Internet technologies faster than Whites and older individuals. Minorities also use smartphones for more news and information activities than Whites, which contradicts traditional usage gap predictions.

Keywords: digital divide, device gap, social diversification, knowledge gap, usage gap
Digital Divide 3.0: The Mobile Revolution, Smartphone Use, and the Emerging Device Gap

Information and communication technologies (ICTs) such as the Internet and mobile connected devices have accelerated an ongoing transformation in the way humans communicate. Just as prior communication innovations such as the telegraph, telephone, and television gave us new ways of consuming and producing mediated messages, Internet connected technologies have done so with amazing speed and enormous impact. The “massification” of American society of the early 20th century was fueled by several factors. The industrialization and urbanization of society led people toward more socially dispersed networks and pulled them away from traditional community and familial group bonds (Rainie & Wellman, 2012). ICTs filled the void left in the wake of this transformation.

The diffusion of ICTs throughout the social system has mirrored the traditional S curve identified by Rogers (1995) in which a small number of innovators adopt a technology, followed by early adopters, early majority, late majority, and finally laggards, eventually leading toward near universal adoption. The diffusion of Internet and mobile devices, however, has left certain demographic groups behind as a result of socio-economic status and structural disadvantages including community infrastructure and education (Chigona, Beukes, Vally, & Tanner, 2009; The World Bank, 2016). The rapid pace of diffusion has also been a factor. The importance of access to high-speed Internet and mobile devices has grown so rapidly that those without access find themselves on the wrong side of a structural, social divide that limits their capacity for inclusion in new social networks.

This digital divide, or the gap between so-called Internet haves and have-nots, has been a problem studied by both scholars and governments for at least two decades (See National Telecommunications and Information Administration 1995, 2000; Norris, 2001; van Dijk, 2005,
In fact, a Google Scholar search of the exact phrase “digital divide” yields approximately 89,500 results since 1996. By comparison, “agenda setting” yields approximately 85,000 results and “selective exposure” just 15,400 results. The issue also frequently attracts attention in the popular press (Cohen, 2016; Safo, 2016; Sengupta, 2016).

“If kids don’t have access to broadband and laptops … then they’re at a disadvantage to those kids who do,” said United States President Barack Obama in July 2015 while announcing his ConnectHome initiative. The plan seeks to expand home broadband Internet access to more than 275,000 low-income households across the country and builds on ConnectEd, a separate program with the goal of providing high-speed Internet access to 99% of K-12 public school students. The broader goal of both programs is to close the digital divide. Census data released in 2014 identified low-income groups (specifically those households with an annual income less than $20,000) as having the lowest rate of Internet access in the United States (Rainie & D’Vera, 2014). Approximately 25 million American households (21%) have no regular Internet access at home or elsewhere like libraries or cafes (Rainie & D’Vera, 2014).

Scholars have focused their research intently on Internet access and usage gaps. Four primary levels of the digital divide have been identified: motivation, access, use, and skills. Internal and external influences inspire motivation to access the Internet; access leads to usage; finally, usage leads to growth in skills (van Dijk, 2005, 2006). These connections, however, are impeded by several demographic factors including income, education, location (e.g., rural vs. urban), age, race, and sex all of which have been explored as factors in the divide. There are two main phases of divide research. Phase I focused primarily on motivation and access: Who has and does not have access and why. As developed countries reached higher levels of Internet
saturation, scholars began focusing on phase II of the divide in an attempt to identify how social groups use the Internet differently.

Much of the recent digital divide research explores the usage gap (Mesch, 2012; Pearce & Rice, 2013; van Dijk, 2006; van Deursen & van Dijk, 2013, 2014; Wei, & Hindeman, 2011); however, constant advances in Internet technology (e.g., gigabit Internet speeds, smartphones, tablets, smart watches) reinforce that access is still a salient issue in America, as well as many other developed and developing countries. In fact, smartphones are one of the fastest growing sources of Internet traffic (Falaki, Lymberopoulos, Mahajan, Kandula, & Estrin, 2010) and are a key indicator of the continuing digital divide, a growing knowledge gap, and a persistent usage gap between demographic groups.

There is a substantial smartphone-dependent population in the United States with limited access to other forms of Internet connected technology (Anderson, 2015). According to studies conducted by the Pew Internet and American Life Project, approximately 68% of Americans now own a smartphone. That is an increase of 33 percentage points since 2011. Of all Americans, 7% rely exclusively on smartphones for Internet access (i.e., smartphone-dependent), and a full 10% are smartphone-limited (i.e., have a smartphone and some access outside the home such as libraries, work, or cafes, but no broadband Internet access in the home). Smartphone dependence is particularly high for certain demographic groups including people aged 18-29 (15%), low-income households making less than $30,000 a year (13%) compared to households making $75,000 or more (1%), and non-Whites including African Americans (12%) and Latinos (13%), compared to Whites (4%)(Anderson, 2015). As Napoli and Obar (2015) point out in their critique of the “emerging under-class” of mobile-only Internet users, “Mobile Internet access represents an inferior form of Internet access on a number of fronts—content
availability, platform and network openness, speed, memory, and interface functionality among 
other things” (p. 330).

The present study applies the knowledge and usage gap hypotheses and the social 
diversification hypothesis (See Mesch, 2007, 2012) specifically to smartphone Internet use and 
device sophistication across demographic groups. Research has only recently begun to address 
the functional *device gap* between Internet connected technologies like smartphones, tablets, and 
personal computers (Chigona et al., 2009; Donner, Gitau, & Marsden, 2011; Mossberger, 
Tolbert, & Hamilton, 2012; Pearce & Rice, 2013). This study helps fill this gap in research and 
expands on the concept by exploring device sophistication (i.e., smartphone dependence and 
multi-modal access) as an underlying factor in the device use disparities observed by other 
scholars. Device sophistication is used to explore 1) how demographic characteristics and online 
activities are associated with smartphone dependence, 2) how the devices people use shape their 
online behaviors and whether those behaviors vary among different demographic groups, and 3) 
how device use is associated with perceptions of need and utility of mobile Internet access. This 
study advances previous research of digital divide phases I and II, specifically how they are 
shaped by, and contribute to, inequality. It tests the knowledge and usage gap hypotheses and the 
social diversification hypothesis and explores whether device sophistication is a root cause of use 
or whether it is a demographic phenomenon. Finally, it measures how key variables impact the 
perceptions of need and utility of smartphone devices. The present study argues that the device 
gap represents a new, third phase in digital divide research.

**Literature Review**

**Knowledge and Usage Gaps**
Most recent digital divide research has focused on whether access to and use of Internet technologies magnify or minimize inequalities related to information diffusion. This thread of research primarily focuses on the intersection of the knowledge gap and usage gap hypotheses to test phase II of the digital divide (Bonfedelli, 2002). The knowledge gap hypothesis was first theorized as a way to better understand the disparities in how information spreads throughout a social system (Donohue, Tichenor, & Olien, 1975; Tichenor, Donohue, & Olien, 1970). “As the infusion of mass media information into a social system increases, segments of the population with higher SES tend to acquire this information at a faster rate than the lower status segments, so that the gap in knowledge between these segments tends to increase” (Tichenor et al., 1970, p. 159). Access to information, or lack thereof, results in social inequality, conflict, and social control through the asymmetrical spread of information. “The problem is not so much one of increasing knowledge, but, frequently, one of relative deprivation of knowledge,” (Donohue et al., 1975, p. 4).

The knowledge gap is often explained in relation to the concept of the “Matthew effect,” which describes the process by which the rich get richer at a rate that makes the poor, poorer (Merton, 1968). In the context of information and communication technologies, wealthy individuals are able to acquire new forms of technology faster; therefore, they use the devices for a greater length of time, more frequently, and more skillfully than disadvantaged segments of the population. This gap in both access and use allows higher SES groups to perpetuate and even increase their advantage over less educated, lower-income individuals (Kraut et al., 2002; Pearce & Rice, 2013; Rogers, 1995).

Foundational studies testing the knowledge gap focused on print news sources as the key medium for transferring information to the public. More recent studies have applied the
knowledge gap hypothesis to the Internet to identify and measure specific consequences of the
digital divide. Wei and Hindman (2011) exposed a significant gap in political knowledge
between low and high SES individuals, specifically for heavy Internet users. In their study, high
SES participants who used the Internet for high levels of information scored an average of 3.41-
points higher than low SES participants who used the Internet for high levels of information on a
12-point political knowledge scale. This was a wider gap than that seen for television,
newspaper, and radio use. There was, however, also a significant knowledge gap for traditional
news users with high SES individuals scoring on average 1.97 points higher on the political
knowledge scale (Wei & Hindman, 2011).

A large amount of research has investigated the association between socio-demographic
variables and online activity (Eastin, Cicchirillo, & Mabry, 2015; Lee, Park & Hwang, 2015; van
representative sample of the Dutch population that identified several different categories of
online activities: information, news, personal development, social interaction, leisure,
commercial transaction, and gaming. They observed significant differences in use between
socio-demographic groups based on these categories. People with low levels of education and
disabled people reported using the Internet for more hours of the day and for different activities
than higher educated individuals. The disadvantaged groups tended to engage in more social
interaction and gaming activities, while those with higher levels of education used the Internet
for more “capital-enhancing” (see Hargittai & Hinnant, 2008) activities such as commercial
transactions and personal development, thus supporting the underlying assumptions of the usage
and knowledge gap hypotheses.
Similarly, Lee, Park, and Hwang (2015), conducted a study of the Korean population that explored demographic characteristics and Internet use differences between wired only Internet users, wired and smartphone users, and wired, wireless, and smartphone users. They found significant differences between male and female Internet users with men more likely to be wired and smartphone users or wired, wireless, and smartphone users than women who were more often wired only users. The study also found that people with higher incomes and more education were more likely to have all three forms of communication technology, which also translated into higher levels of Internet use (Lee, Park, & Hwang, 2015). This finding counters that of van Deursen and van Dijk (2013) in that higher educated and higher income groups used the Internet more frequently. This suggests that the amount of time spent using the Internet daily is not necessarily a reliable indicator of use or skill. Both studies provide evidence that use and access gaps are still relevant, even in developed countries.

Previous studies have looked at differences in users/non-users and others have looked at differences in use, but few studies have integrated the two ideas. The current study merges the larger trends in digital divide research and explores the usage gap in the context of smartphone-dependent Internet users compared to multi-modal Internet users (i.e., those who use mobile handheld devices as well as laptop or desktop devices). As previously noted, smartphones are a primary source of Internet connection for disadvantaged groups. Understanding how these individuals use devices compared to other more traditionally advantaged groups will shed new light on the usage gap and how the presence of a device gap may be masking persistent inequality in both use and access.

Similar to the usage gap, the social diversification hypothesis looks beyond the dichotomous haves and have-nots of early digital divide research. Instead of focusing on
divergent online activities, however, the diversification hypothesis explores the *motivations* behind types of Internet activities conducted by diverse groups (Mesch, 2007, 2012). The framework for understanding the diversification hypothesis poses two key research questions: (1) How does culture and ethnicity impact use of Internet social applications? and (2) Are there any key motivations associated with media choice differences among different social groups?

Two competing views of Internet access exist regarding in relation to the diversification hypothesis: normalization and stratification. The normalization perspective suggests that the rise of the information society and Internet saturation have the ability to reduce existing social inequalities (Mesch, 2012). The stratification perspective, however, argues in line with the knowledge gap and social enhancement perspective that the Internet reflects existing social inequalities and may actually magnify them (Mesch, 2012; Norris, 2001; van Dijk, 2005). Mesch (2012) uses these two concepts to frame his social diversification argument. The diversification hypothesis specifically has been applied to disadvantaged ethnic minority populations in Israel (i.e., Arab-Israelis). Mesch (2012) argues that these groups will use ICTs to break the boundaries of their ethnic status and to increase their social support.

Research has generally supported the stratification perspective and the diffusion of innovations model, which illustrates who in the early and middle stages of technology adoption, adopters are more likely to be higher SES individuals (Norris, 2001; Rogers, 1995). Further studies related to the communication infrastructure theory (Kim & Ball-Rokeach, 2006) show SES is a significant factor in access, while ethnicity impacts social connectedness on the Internet (e.g., amount of interpersonal communication on Internet sites). Because higher SES groups access Internet technology earlier in the diffusion process, they have more time to develop use
skills and broader online networks compared to disadvantaged groups, which in turn shape online activities and motivations.

The implications of studies into normalization, stratification, and communication infrastructure support the notion that differential use of the Internet by minority and majority populations is attributable to different motivations associated with communication infrastructure. The outcome of such disparities is that minorities and the disadvantaged generally have less social capital and less social support. Social capital in the context of Internet relates to how access and use increases opportunities to obtain information, employment opportunities, human capital, goods, and services (Anderson et al., 1995; DiMaggio, Hargittai, Neuman & Robinson, 2001). Mesch (2012) argues in his conception of the diversification hypothesis that computer-mediated communication (CMC) provides the opportunity for disadvantaged groups to overcome the social and physical segregation that reduces access to social capital. Disadvantaged groups use CMC to overcome social isolation and to expand their social groups while majority groups use CMC more for maintaining existing social ties (Mesch, 2012). Diversification through CMC may eventually lead to a collapsing of social hierarchies and increased social ties, which can then reduce inequality.

The current study tests the diversification hypothesis by measuring the use of smartphones for “social enhancement” activities and comparing across demographic groups. The conception of social enhancement for this study includes all social uses of smartphones and does not distinguish between social “network maintenance” and “expansion.” As Mesch (2012) points out, “Both uses, for expansion and for maintenance of social ties, are linked to formation of social capital” (p. 322). Therefore, in this study all social use is measured and analyzed for differences between groups. Additionally, news and information use is also measured to compare
across demographic groups and to test the knowledge gap hypothesis, which parallels the stratification perspective.

Demographics

Demographic characteristics have long been used to study both access to and use of the Internet and its related technologies. This study builds on previous research by identifying how demographics are related to device access, use, and perceptions of utility. Four key demographic characteristics are explored in this study: sex, age, race, and education.

Sex has been associated with Internet use in numerous studies (Jackson, Ervin, Gardner & Schmitt, 2001; Jones, Johnson-Yale, Millermaier, & Perez, 2009; van Deursen & van Dijk, 2013). Women tend to use the Internet for more communicative functions (Jackson et al., 2001; Jones et al., 2009) while men use it more for entertainment, news, information, and commerce (van Deursen & Van Dijk, 2013). Research shows that women are more interpersonally oriented while men are more information/task oriented (Jackson et al., 2001; Eagley & Johnson, 1990).

Age is also a significant factor in Internet use. Younger users play more games, surf the web for enjoyment, and communicate through Internet SNSs. Older users, on the other hand, use the Internet for more shopping, e-mailing, and searching for health-related information. Scholars have also argued that socio-economic status (often measured through income, employment status, and education) is associated with productively using the Internet. Dimaggio (2004) argued that higher SES status individuals use the Internet for more productive tasks while lower SES groups use it for more general and superficial activities. When SES is broken into its constituent parts, education becomes one of the most important demographic characteristics studied. Education is also the main characteristic used to explain the knowledge and usage gap hypotheses (van Deursen & van Dijk, 2013; van Dijk, 2005).
Hypotheses

The present study synthesizes broad areas of the digital divide using the usage gap and social diversification hypotheses. It also extends divide research by applying the assumptions of the usage gap to connected devices; it tests the social diversification hypothesis using a nationally representative sample within the United States. The study specifically looks at how smartphone Internet use differs between key demographic characteristics (i.e., race, sex, age, income, and education), how device sophistication is associated with Internet use, and how use is associated with perceived need and utility of smartphone Internet access. Device sophistication is broken into two key categories: smartphone-dependent users (e.g., limited to handheld mobile devices) and multi-modal users (e.g., laptop, desktop, smartphone, tablet etc.).

Although numerous studies have exposed significant disparities in Internet use and access—and more recently, an Internet connected device gap—research into smartphone Internet use, specifically, and how it differs among demographic groups, is limited, especially in the context of developed countries like the United States (See Gonzales, 2015; Mesch, 2012; and Pearce & Rice, 2013). This is a particularly important gap in research to fill as smartphones represent one of the fastest growing categories of new Internet traffic. They are also a key resource for those on the wrong side of the digital divide. Global mobile Internet data use grew by 69% in 2014 alone and approximately 497 million new mobile Internet devices were added in 2014, 88% of which were smartphone devices (Cisco, 2015). In fact, in 2010 mobile broadband Internet accounts overtook fixed (e.g., PC-based) subscriptions and are expected to total 84% of all broadband connections in developing countries by 2016 (Napoli & Obar, 2015).

Research has shown that lower SES groups are often under-connected to the Internet due to poor connection speeds, limited access points, and mobile-only dependence (Rideout & Katz,
Identifying which demographic groups have access to the most sophisticated connected devices helps reveal who exactly is impacted by limited access and tests a revision of phase I of the digital divide. Previous studies have found that demographic characteristics are associated with how people connect to the Internet. Disadvantaged groups including minorities, women, lower income, and less educated people typically have the fewest access points and higher rates of smartphone-dependence (See Rainie & D’Vera, 2014). Age, however, is more complicated. The net-generation, or digital natives, are often more connected and more skillful in using ICTs than older generations (Ballano, Uribe, & Munte-Ramos, 2014). Older individuals, however, generally report greater levels of perceived social support (Shaw, 2005; Shaw, Krause, Chatters, Connell, & Ingersoll-Dayton, 2004; Wethington & Kessler, 1986). Younger individual, therefore, may be able to close this gap through their use of ICTs (See Wang & Wellman, 2010). Hypothesis one addresses the device access gap by looking at the association between demographics and smartphone dependence:

H1: Demographics including (a) race, (b) sex, (c) age, (d) income, and (e) education are associated with smartphone dependence. White, male, higher income, and higher educated individuals will have access to more sophisticated devices while less advantaged groups including minorities, women, younger individuals, lower income, and less educated individuals will be more likely to have access limited to less sophisticated devices (i.e., smartphones).

Hypotheses 2 and 3 make predictions regarding the normalization and stratification perspectives as defined by the social diversification hypothesis (See Mesch, 2012). Numerous usage gap studies investigating Phase II of the digital divide have found Internet use disparities between demographic characteristics, thus supporting the stratification perspective (Buchi, Just,
& Latzer, 2015; Eastin et al., 2015; Pearce & Rice, 2013; Anderson, 2015). The usage gap makes predictions about what people do when they have access to the Internet while the access gap (tested in H1) is about who owns or uses particular types of devices. In studies conducted in developing countries, demographic characteristics including most significantly, age, but also sex, and education, have been key indicators of Internet activity (Chigona, et al., 2009; Donner, Gitau, & Marsden, 2011). These studies expose a gap in the way typically advantaged (employed, male, younger Internet users who live in urban areas) and disadvantaged groups use the Internet. Advantaged groups are more likely to use the Internet for activities such as information seeking and news consumption. Other studies, however, have uncovered instances in which disadvantaged minority groups actually reverse the traditional usage gap to support the normalization perspective. In these cases, disadvantaged groups may actually reduce social inequalities through their use of the Internet (See Gonzales, 2015; Mesch, 2012). For example, Arab-Israelis reported using social networking sites (SNSs) more frequently to expand their social networks compared to the majority Israeli population (Mesch, 2012).

H2 predicts that minorities, women, younger users, lower income, and less educated individuals will use smartphones for more social enhancement activities compared with advantaged groups, thus supporting the normalization perspective. If there is a significant, difference between demographic groups in social enhancement activity, it will suggest that smartphone Internet access may reduce or even close aspects of the usage gap that impact access to social capital. H3, however, tests the difference in informational activity conducted by demographic groups. Advantaged demographic groups (i.e., Whites, men, older, higher income, and higher educated) are predicted to use smartphones for more informational activities. This
prediction is in line with previous usage gap studies (see van Deursen & van Dijk, 2013, 2014) and will provide additional insight into how demographic groups use smartphones.

H2: Demographics including (a) race, (b) sex, (c) age, (d) income, and (e) education are associated with types of smartphone use such that minority groups, women, younger individuals, lower income, and less educated individuals, will use the devices for more social enhancement activity than Whites, men, older individuals, higher income, and higher educated individuals.

H3: Demographics including (a) race, (b) sex, (c) age, (d) income, and (e) education are associated with types of smartphone use such that White, male, older Internet users, higher income, and higher educated individuals will use smartphones for a higher proportion of news and information activities compared to disadvantaged groups.

Research questions 1, 2, and 3, on the other hand, explore difference in smartphone use among disadvantaged groups who have multi-modal access compared to advantaged groups with similar access. Previous research has found that the number of device access points individuals have leads to disparities in the quality of online activities conducted (See Hassani 2006; van Deursen & van Dijk, 2013). Individuals who have more device access points participate in more instrumental online activities including news, health, and product information seeking, shopping, and banking than those who have fewer access points (Hargittai, 2010; Hassani, 2006; Lee, Park & Hwang, 2015). Furthermore, those with more Internet connected devices are typically White, male, higher educated, younger, have had Internet access longer, and have greater usage skills. Whether or not demographic characteristics, skills, or the devices themselves cause these use differences, is unclear.
In order to provide some clarity to this problem, the current study explores how device sophistication (i.e., smartphone-dependency or multi-modal access) impacts use rather than number of accessible devices, or skill. If a device gap is present, any observed association between socio-demographic characteristics and use predicted in H2 should be significantly reduced as device sophistication increases among the traditionally less advantaged groups (i.e., minorities, women, younger, lower income, and less educated individuals), therefore, mitigating the usage gap and exposing a device gap. In other words, if minorities, women, younger, lower income, and less educated individuals only use smartphone devices differently when they have unequal access to connected devices it would suggest there is something about the devices themselves that is impacting the types of activities individuals are conducting. If, however, a usage gap persists or even grows between relevant demographic groups who have similar levels of device access, then it would provide additional support to the usage gap, which argues that a digital divide continues to exist between demographic groups because advantaged groups perform more capital enhancing activities than disadvantaged. Exploring this relationship will help explain how device sophistication impacts use in a distinct way compared to demographic variables. RQ1, RQ2, and RQ3 probe how device access (i.e., smartphone only vs. multi-modal) both mediates and moderates the relationship between demographics and use. This relationship is illustrated in Figure 1.

RQ1: Does device sophistication mediate the relationship between Internet use and (a) race, (b) sex, (c) age, (d) income, and (e) education? If device sophistication acts as a mediator, how does it impact the relationship between demographics and online activities?
RQ2: Does device sophistication moderate the relationship between Internet use (i.e., social enhancement and news and information activities) and (a) race, (b) sex, (c) age, (d) income, and (e) education?

RQ3: Does device sophistication acts as a moderated-mediator between demographics and use? If so, how does the indirect effect of demographic variables through device sophistication vary at different levels of device sophistication?

Figure 1. Model 74 of the PROCESS macro illustrates the moderation-mediation model of device sophistication on demographics and smartphone use.

Access to the Internet anywhere, any time is an increasingly essential aspect of inclusion in the 21st century socio-economic structure. For example, Kim and Ball-Rokeach (2006) found that differences in communication opportunity structures are associated with different levels of political, cultural, and social capital. In other words, access to the Internet and connected devices increases an individual’s capital resources. Traditionally advantaged individuals, specifically Whites, men, those with greater income, and higher levels of education, should be less willing to give up their smartphones because of the perception that they have the most to lose by doing so, whereas disadvantaged groups who use smartphones will be more willing to give them up.
According to social diversification and the stratification perspective, advantaged groups have used smartphone devices the longest, obtained the most skills, and have the greatest motivation for keeping them (Mesch, 2012). Type of use is also a key factor in perceptions of smartphone utility. Smartphone owners who use their phones for a small proportion of social enhancement or news and information activity are predicted to express a greater willingness to give up their smartphones regardless of the number of device access points available. Although smartphone-dependent users have fewer options for Internet connection, and thus fewer chances to take advantage of the social capital of the Internet, they will see less need for smartphones in their lives if they are not used for social enhancement and/or news and information activities. This is an important proposition to explore because disadvantaged groups have the most to gain from Internet access. If they do not see a need for the devices, they will not be able to capitalize on the gains in social capital and information resources available from online access.

H4: Demographics including (a) race, (b) sex, (c) age, (d) income, and (e) education are associated with willingness to give up smartphones.

H5: The association between (a) race, (b) sex, (c) age, (d) income, and (e) education and willingness to give up smartphones is moderated by device sophistication such that as device sophistication increases, there will be an increase in perceptions of need for advantaged demographic groups. However, for smartphone-dependent users, there will be a decline in perceptions of need.

H6: The association between (a) age, (b) race, (c) sex, and (d) education and willingness to give up smartphones is moderated by smartphone use such that as social enhancement and news and information activity increase the association between demographics and willingness to give up smartphones is reduced.
Method

Sample

Data for this study were collected on behalf of the Pew Internet and American Life Project (2012). Telephone interviews with a nationally representative sample of 2,254 adults were conducted between March 15 and April 3, 2012. Topics covered in the interviews included Internet access, use, and perceptions of the importance of the Internet in respondent’s lives. Random digit dialing was used to collect survey responses and the final sample was weighted to represent the American adult population. The sample response rate was 11%.

Respondents were slightly more likely to be female ($n=1,244, M=55.2\%$) and, on average, were 56 years old. In terms of race, most respondents were White (78.2\%) followed by Black or African American (12.4\%), two or more races (2.3\%), and Asian or Pacific Islander (3.6\%). More than half (54.2\%) of the respondents reported an annual family income before taxes during the previous year of less than $75,000. Over one-third of the respondents (36\%) had completed college or greater education. Respondents reported the following rates of Internet access: No Internet access ($n = 357, 15.8\%$), smartphone-dependent ($n = 73, 3.2\%$), laptop/desktop only ($n = 711, 31.5\%$), and multi-modal ($n = 1,110, 49.3\%$).

Measures

**Device sophistication.** This variable was measured by asking respondents what Internet connected devices they own: desktop (58\%), laptop (61\%), cellphones including smartphones (88\%), handheld reading devices such as the Kindle or Nook (18\%), and tablet computers (18\%). In order to isolate smartphone users, all mobile phone owners were asked whether their phone was a smartphone (40\%) or not (46\%). Approximately 13\% of all respondents reported not having access to a cell phone at all.
I recoded the previous questions to create two separate device sophistication variables. First, I created a dichotomous variable with smartphone-dependent users coded as -.5 and multi-modal users as .5 ($M = .44$, $SD = .24$). I also created a second device sophistication variable for the moderated-mediation analyses. For this variable I coded no-access as 0, smartphone-dependence (i.e., limited to smartphone access) was 1, laptop/desktop only access was 2, and multi-modal access was 3 ($M = 2.14$, $SD = 1.07$).

Types of use. Questions were broken down into two main categories: news/information and social enhancement activity. All respondents who reported using the Internet, sending e-mail on their cell phone, or downloading apps to their cell phone ($N=953$) were recorded.

News/information activity. This measure was created using five specific questions answered on a simple yes or no basis ($N = 939$). Questions included, “Do you ever use your cellphone to”: 1) “get news online?”, (2) “look for health or medical information online?”, (3) “visit a local, state, or federal government website?”, (4) “Get up-to-the minute traffic or public transit information so you could find the fastest way to get somewhere?”, and (5) “Keep up with news related to the election or politics?” The answers were coded on a yes=1 or no=0 basis creating a 0-5 scale with 0 being no activity and 5 being most activity. Do not know and no response answers were coded as missing. This measure reached the established threshold for reliability (Cronbach’s alpha = .63).

Social enhancement activity. This measure was created using seven specific questions answered on a simple yes or no basis ($N = 894$). Questions included, “Do you ever use your cellphone to”: (1) “send or receive an e-mail?”, (2) “coordinate a gathering?”, (3) “access a social networking site like Facebook, LinkedIn, or Google Plus?”, (4) “use Twitter?”, (5) Exchange text messages with someone else who was watching the same [television] program in a
different location?”; (6) “Post your own comments online about the [television] program you were watching?”; and (7) “Send text messages related to the election campaign to friends, family members or others?” All answers were coded as yes=1 or no=0 creating a scale of 0-7 with 0 being no activity and 7 being most activity. Do not know and no response answers were coded as missing. This measure reached the established threshold for reliability (Cronbach’s alpha = .64).

**Smartphone need.** Survey respondents were asked a single question to measure smartphone need ($M = 1.91$, $SD = .81$). The question asked respondents whether “thinking about you cell phone do you think it is something:” (1) “you could live without” (37%), (2) “would miss having, but could probably do without” (33%), or (3) “something you can't imagine living without (29%)?” This single question created a 1-3 scale with 1 being “could live without” and 3 being “can’t imaging living without it.”

**Demographic characteristics.** Age ranged from 18-99 years old ($M = 52.4$, $SD = 19.4$). Sex was included as a dichotomous variable with male=1 ($n = 1,010$, 44.8%) and female=2 ($n = 1,244$, 55.2%). Education was measured as the last grade or class completed and was broken into eight different categories. The categories consisted of none or grades 1-8 ($n = 51$, 2.3%); high school incomplete ($n = 162$, 7.2%); high school graduate ($n = 620$, 27.5%); technical, trade or vocational school after high school ($n = 49$, 2.2%); some college ($n = 538$, 23.9%); college graduate ($n = 465$, 20.6%); and post-graduate training/professional school ($n = 345$, 15.3%). Race was recorded as White ($n = 1763$, 78.2%) and all other ($n = 446$, 19.8%). Income was measured by 9 different categories of family income in the last year (2011). Categories included less than $10,000 up to more than $150,000.

**Data Analysis**
All analyses reported were conducted on a weighted sample with the exception of analyses run in PROCESS. Pew applies standardized weights to its data in order to better represent population demographic characteristics. A Chi-square analysis and univariate analyses of variance (ANOVA) were conducted to identify the rates of smartphone dependence among key demographic groups. Multiple regression analyses were conducted to test H2 and H3 to test how demographics are associated with social enhancement activity and news and information activity. RQ1, RQ2, and RQ3 explore the interactions between device sophistication and demographics on types of online activities. A moderation-mediation model was tested using Hayes’ PROCESS macro model 74 to analyze these interactions (See Figure 1). Individual mediation and moderation analyses were conducted using Hayes’ PROCESS macro to further analyze significant findings. H4 was tested with a multiple regression analysis to identify the amount of variance demographic characteristics explain in willingness to give up smartphones. Finally, moderation analyses were performed using PROCESS to test the interactions involved in H5 and H6 (See Table 1).

Results

H1 tested whether demographic characteristics including (a) race, (b) sex, (c) age, (d) income, and (e) education are associated with different levels of device sophistication. Weighted data were used for these analyses. Minority respondents \( n = 414 \) differed significantly from White respondents \( n = 1,444 \) in their access to Internet connected devices, \( \chi^2 (2) = 31.89, N = 1,858, p < .001, \phi = .13 \). Table 2 shows minorities were significantly more likely to be smartphone-dependent. Interestingly, however, they were also more likely to report having multi-modal access. Whites, on the other hand, were more likely to have only laptop or desktop devices. H1a was, therefore, partially supported.
Table 2. Frequencies of Internet device access group based on race

<table>
<thead>
<tr>
<th></th>
<th>No Access</th>
<th>Smartphone-dependent</th>
<th>Laptop/Desktop Only</th>
<th>Multi-modal users</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>242 (14.4%, -3.3)</td>
<td>45 (2.7%, -2.2)</td>
<td>590 (35.0%, 6.0)</td>
<td>809 (48.0%, -2.4)</td>
</tr>
<tr>
<td>All other</td>
<td>106 (20.4%, 3.3)</td>
<td>24 (4.6%, 2.2)</td>
<td>109 (21.0%, -6.0)</td>
<td>281 (54.0%, 2.4)</td>
</tr>
</tbody>
</table>

Note. Numbers in parentheses are percent (rows) of total White and all other minorities that comprise each category along with adjusted standardized residuals: Residuals greater than 1.96 indicate a significant departure from expected.

As shown in Table 3, women ($n = 1,158$) do not differ significantly from men ($n = 1,093$) in access to Internet connected devices, $\chi^2 (3) = .74, N = 2,251, p > .05$. H1b was not supported.

Table 3. Frequencies of Internet device access group based on sex

<table>
<thead>
<tr>
<th></th>
<th>No Access</th>
<th>Smartphone-dependent</th>
<th>Laptop/Desktop Only</th>
<th>Multi-modal users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>172 (15.7%, -.2)</td>
<td>38 (3.5%, .6)</td>
<td>335 (30.6%, -.9)</td>
<td>548 (50.1%, .8)</td>
</tr>
<tr>
<td>Female</td>
<td>185 (16.0%, .2)</td>
<td>35 (3.0%, -.6)</td>
<td>376 (32.5%, .9)</td>
<td>562 (48.5%, -.8)</td>
</tr>
</tbody>
</table>

Note. Numbers in parentheses are percent of total male and female participants that comprise each category along with adjusted standardized residuals: Residuals greater than 1.96 indicate a significant departure from expected.

Univariate analysis of variance (ANOVA) tests were conducted to analyze the impact of (c) age, (d) income, and (e) education on device sophistication (See Table 4). Weighted data were used in this analysis as well. Demographic characteristics were entered as dependent variables to conduct these analyses. The four groups of device sophistication significantly differed by age, $F(3, 2299) = 184.04, p < .001, \eta^2 = .19$. Tukey pairwise comparisons revealed that the no-access group ($M = 58.56, SD = 18.83$) was significantly older than the laptop/desktop ($M = 51.91, SD = 16.93$) group. Both the no access and laptop/desktop groups were significantly
older than the smartphone-dependent \((M = 40.48, SD = 18.33)\) and multi-modal groups \((M = 38.55, SD = 18.16)\). There was no significant difference between smartphone-dependent and multi-modal groups based on age.

Device sophistication also differed significantly based on income, \(F(3, 1873) = 111.30, p < .001, \eta^2 = .15\). Tukey pairwise comparisons showed that income levels of individuals without access to the Internet \((M = 2.81, SD = 1.75)\) and smartphone-dependent users \((M = 3.03, SD = 2.02)\) reported significantly lower incomes than those reported for laptop/desktop only \((M = 4.78, SD = 2.16)\) and multi-modal users \((M = 5.52, SD = 2.38)\). Laptop/desktop only users also reported significantly lower income than multi-modal users. There was no difference between no-access and smartphone-dependent users on reported income.

Finally, device sophistication differed based on educational attainment, \(F(3, 2280) = 126.00, p < .001, \eta^2 = .14\). Tukey pairwise comparisons showed that the education level of individuals without access to the Internet \((M = 2.99, SD = 1.48)\) and smartphone-dependent users \((M = 3.23, SD = 1.45)\) were significantly lower than those reported for laptop/desktop only \((M = 4.36, SD = 1.56)\) and multi-modal users \((M = 4.76, SD = 1.60)\). Laptop/desktop-only users also reported significantly lower income than multi-modal users. There was no difference between no-access and smartphone-dependent users on reported income.

<p>| Table 4 |
|-------------------|-------------------|-------------------|-------------------|
|                  | No Internet access | Smartphone-dependent | Laptop/Desktop-only | Multi-modal |
| <strong>Age (M (SD))</strong> | 58.56 (18.83)(_a) | 40.48 (18.33)(_b) | 51.91 (16.93)(_c) | 38.55 (18.16)(_b) |</p>
<table>
<thead>
<tr>
<th>Income before taxes</th>
<th>2.81 (1.75)_a</th>
<th>3.03 (2.02)_a</th>
<th>4.78 (2.16)_b</th>
<th>5.52 (2.38)_c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>2.99 (1.48)_a</td>
<td>3.23 (1.45)_a</td>
<td>4.36 (1.56)_b</td>
<td>4.76 (1.60)_c</td>
</tr>
<tr>
<td>1-less, 7=more</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M (SD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Means that do not share subscripts are significantly different ($p < .05$, Tukey comparison).

H2 predicted that (a) race, (b) sex, (c) age, (d) income, and (e) education would be associated with types of smartphone use, such that minorities, women, younger individuals, those lower paid, and less educated would use the devices for a greater proportion of social enhancement activities. Data for these analyses were weighted. All predictor variables were entered in the same block of a regression analysis. This model predicted significant variance in the criterion, $R^2 = .25$, $F(5, 1609) = 107.83, p < .001$. Race was a marginally significant predictor of social enhancement activity, $b = -.04, t = -1.92, p = .056, r^2_{partial} = .002$. Minorities were more likely to conduct social enhancement activities on smartphones than Whites. H2a approached significance. Sex significantly predicted social enhancement activity, $b = .06, t = 2.55, p = .01, r^2_{partial} = .004$. Women were more likely to perform social enhancement activities on their smartphones than men. H2b was supported. Age significantly predicted social enhancement activity, $b = -.47, t = -21.57, p < .001, r^2_{partial} = .22$. Younger smartphone users were more likely to conduct social enhancement activity. H2c was supported. Income significantly predicted social enhancement activity, $b = .16, t = 6.32, p < .001, r^2_{partial} = .024$. Higher income individuals were more likely to use their smartphones for social enhancement activity than lower income users. Although results were significant, H2d was not supported because results contradicted the
social diversification hypothesis. Finally, education significantly predicted social enhancement activity, $b = .071$, $t = 2.88$, $p < .001$, $r^2_{partial} = .005$. Higher educated individuals were more likely to conduct social enhancement activities on their smartphones than less educated people. Again, although results were significant, H2e was not supported because results contradicted the social diversification hypothesis.

In sum, H2 had mixed support. Minorities, women, and younger Internet users performed significantly more social enhancement activities on their smartphone devices than Whites, men, and older individuals. These findings support the normalization perspective. Income and education, however, had the opposite effect than predicted and support the stratification perspective with income and education being positively associated with social enhancement activity. In these analyses, however, it should be noted that there were quite small effect sizes for all but the age demographic. This observation shows that age is by far the most important predictor of social enhancement activity with younger smartphone users conducting significantly more social enhancement activities on their mobile devices.

H3 predicted that (a) race, (b) sex, (c) age, (d) income, and (e) education would be associated with types of smartphone use such that White, male, older, higher earning, and higher educated individuals would use smartphones for a greater proportion of news and information activities. Data for these analyses were weighted. All predictor variables were entered in the same block of the regression analysis. This model predicted significant variance in the criterion, $R^2 = .17$, $F(5, 1609) = 65.69$, $p < .001$. Race significantly predicted news and information activity, $b = -.05$, $t = -2.27$, $p < .001$, $r^2_{partial} = .003$. Minorities performed more news and information activity on their smartphones compared to Whites. Although significant results were found, H3a was not supported because it contradicted predictions. Sex did not significantly
predict news and information activity, $b = -.03, t = -1.23, p = .22$. H3b was not supported. Age significantly predicted news and information activity, $b = -.34, t = -14.84, p < .001, r^2_{\text{partial}} = .12$. Similar to social enhancement, younger smartphone users were more likely to conduct news and information activities on their smartphones; however, this contradicts the predicted direction of the relationship. H3c was not supported. Income significantly predicted news and information activity, $b = .18, t = 6.76, p < .001, r^2_{\text{partial}} = .03$. Higher income individuals conducted more news and information activities on their smartphones. H3d was supported. Finally, education significantly predicted news and information activity, $b = .11, t = 4.38, p < .001, r^2_{\text{partial}} = .014$. Higher educated individuals performed more news and information activities on their smartphones. H3e was supported.

In sum, H3 had mixed support. Higher income, and higher educated individuals performed more news and information activities on their smartphones, thus supporting the knowledge gap hypothesis and stratification. Race and age, however, had the opposite relationship than was predicted. Sex was not a significant predictor of news and information activity. Again, it should be noted that there were quite small effect sizes for all predictors with the exception of age, which had robust effect sizes for both activities. These observations show that age is the most telling, and arguably most important, indicator of the type of activities individuals are conducting on their smartphones.

RQ1 sought to explore if device sophistication mediates the relationship between Internet use and (a) race, (b) sex, (c) age, (d) income, and (e) education. RQ2, on the other hand, sought to understand how device sophistication moderates the relationship between Internet use (i.e., social enhancement and news and information activities) and (a) race, (b) sex, (c) age, (d) income, and (e) education. If observed differences in online activities between disadvantaged and
advantaged demographics significantly decrease as device sophistication increases, it would indicate a shrinking usage gap and suggest a mitigating effect on the knowledge gap for news and information activity and a normalization effect for social enhancement activity. If, however, observed differences in online activities between disadvantaged and advantaged demographic groups increase as device sophistication increases, then it would indicate an increasing knowledge gap regarding news and information use, and a stratification effect for social enhancement activity.

RQ3 combines RQ1 and RQ2 to understand how device sophistication acts as a moderated-mediator between demographics and use. In other words, RQ3 probes how the indirect effect of demographic variables through device sophistication varies at different levels of device sophistication. A moderated-mediation analysis was run in Hayes’ PROCESS macro using model 74 in order to test RQ1, RQ2, and RQ3 (Hayes, 2013). Simple mediation and moderation analyses were then conducted to decompose the significant interactions observed. Analyses for RQ1, RQ2, and RQ3 were conducted on unweighted days because PROCESS does not compute weighted results. These analyses were also run excluding the no-access group in order to get more accurate results.

In this moderated-mediation model, device sophistication acts as both the moderator and the mediator (See Figure 1). In other words, different levels of device sophistication explain how demographic characteristics impact gaps in types of online activities conducted (i.e., social enhancement and news and information) while also explaining the relationship between demographics and online activities. First, I ran the model separately for each demographic factor with remaining demographic factors entered as covariates to control for confounds. If results
were significant, I reran the models without covariates in order to maximize my sample size because significantly fewer participants agreed to give responses for income.

The first half of the model predicted that demographics would be associated with device sophistication. Race $b = -.12, t = -2.07, p = .038$, age $b = -.01, t = -14.51, p < .001$, income $b = .06, t = 8.82, p < .001$, and education, $b = .05, t = 5.92, p < .001$, were significant predictors of device sophistication in the moderated-mediation model. Minorities, younger, higher income, and higher educated individuals had higher levels of device sophistication. However, sex, was not significant, $b = .01, t = .42, p > .05$.

The first half of the model also was tested in relation to news and information activity. Race, $b = -.12, t = -3.52, p < .001$, sex, $b = -.06, t = -2.11, p = .03$, age $b = -.01, t = -14.14, p < .001$, income $b = .05, t = 8.82, p < .001$, and education, $b = .05, t = 5.92, p < .001$, were significant predictors of device sophistication in the moderated-mediation model. Minorities, men, younger, higher income, and higher educated individuals had higher levels of device sophistication.

The full model tested how demographics would impact device sophistication. In other words, would traditionally disadvantaged demographics (e.g., minorities, women, older individuals, less educated, and lower paid) report less device sophistication, thus leading to differential rates of social enhancement activity and news and information activity? Or would the opposite happen? Following are results for both social enhancement and news and information activity broken down by demographic characteristics. In other words, results for the moderated-mediation of device sophistication on the association between race and social enhancement and news and information are reported first, followed by the each additional demographic
characteristics. Simple mediation (RQ1) and moderation (RQ2) analyses were conducted if there was a significant effect for the moderated-mediation model.

The interaction between race and device sophistication on social enhancement activity was not significant, $b = -.16$, $t = -1.01$, $p > .05$. The interaction between race and device sophistication on news and information activity, however, was significant, $b = .30$, $t = 2.26$, $p = .024$. The indirect effect of race and device sophistication on news and information activity was also significant, $b = -.11$, 95% CI [-.20, -.04]. Additional investigation of the mediation effect showed that race had a significant direct effect on news and information seeking, $b = -.23$, $t = -3.07$, $p = .002$, as well as a significant indirect effect, $b = -.14$, 95% CI [-.22, .05], therefore, acting as a partial mediator. I then ran a simple moderation analysis to investigate the interaction effect further. The conditional effect of race on news and information activity at levels of device sophistication was significant at the mean (excluding the no-access group) of device sophistication ($M = 2.53$, $SE = .08$), $b = -.25$, $t = -3.32$, $p < .001$, and at one standard deviation below the mean, $b = -.42$, $t = -3.74$, $p < .001$. Analysis of the simple slopes shows that less device sophistication actually increases the gap in news and information use between minorities and Whites. Among multi-modal users, however, the differences are reduced to non-significance (See Figure 2).
Figure 2: Minorities with lower levels of device sophistication perform more news and information activities on their smartphone compared to Whites. Among multi-modal users, however, the differences are reduced to non-significance.

Next, I tested the interaction between sex and device sophistication on Internet activity. The effect between sex and device sophistication on social enhancement activity was not significant, $b = -.04, t = -.51, p > .05$. The interaction of sex and device sophistication on news and information activity was also not significant, $b = -1.13, t = -1.22, p > .05$.

Device sophistication acted as a moderated mediator between age and social enhancement activity. The interaction effect between age and device sophistication was significant and negative, $b = -.01, t = -3.52, p < .001$. The conditional indirect effect of age on
social enhancement activity was significant and negative at one standard deviation below the mean of device sophistication, \( b = -.01 \) 95% CI [-.01, -.006], at the mean, \( b = -.007 \) 95% CI [-.01, -.005], and at one standard deviation above the mean, \( b = -.005 \) 95% CI [-.007, -.003]. Additional investigation of the mediation effect showed that age had a significant indirect effect on social enhancement activity through device sophistication, \( b = -.01 \) 95% CI [-.01, -.006], therefore, acting as a partial mediator. I then conducted a simple moderation analysis of the effect of device sophistication on the relationship between age and social enhancement activity. The conditional effect of device sophistication on the association was significant and negative one standard deviation below the mean of device sophistication, \( b = -.03, t = -10.88, p < .001 \), at the mean, \( b = -.03, t = -17.94, p < .001 \), and at one SD above the mean, \( b = -.04, t = -15.56, p < .001 \). Analysis of the simple slopes reveals that the gap in social enhancement activity between younger and older individuals’ rates of social enhancement activity grew as device sophistication increased. Additionally, the gap in social enhancement activity among younger users grew as device sophistication increased (See Figure 3).
Figure 3. Social enhancement activity significantly declines as people age regardless of the number of devices they own. Young, multi-modal users have the highest rates of social enhancement activity. All three slopes are significant.

The interaction between age and device sophistication on news and information activity was not significant, $b = -0.003$, $t = -1.18$, $p > .05$. Mediation and moderation analyses were, therefore, not conducted.

The interaction effect between income and device sophistication on social enhancement activity was significant, $b = 0.10$, $t = 3.39$, $p < .001$. The conditional indirect effects of device sophistication on income and social enhancement activity was significant and positive at one standard deviation below the mean of device sophistication, $b = 0.05$, at the mean, $b = 0.07$, and at
one standard deviation above the mean, $b = .08$. Mediation analysis reveals that the *direct* effect of income on social enhancement activity was not significant, $b = .002, t = .14, p > .05$. The indirect effect of income on social enhancement activity through device sophistication, however, was significant, $b = .06, 95\% \text{ CI } [.05, .08]$; therefore, device sophistication fully mediated this relationship. Moderation analysis showed the conditional effects of income on social enhancement activity at levels of device sophistication were significant and *negative* at one standard deviation below the mean of device sophistication, $b = -.06, t = -2.28, p = .02$; and significant and *positive* at one standard deviation above the mean, $b = .05, t = 2.14, p = .03$. Analysis of the simple slopes revealed that the gap in social enhancement activity between higher paid and lower paid individuals was significant and positive for multi-modal users; however, this association reversed for those with less sophisticated devices (See Figure 4).
Figure 4. Social enhancement activity is significantly higher among higher income individuals with multi-modal access. The association is reversed for those with fewer devices.

The interaction effect between income and device sophistication on news and information activity was also significant, $b = .18$, $t = 7.51$, $p < .001$. The conditional indirect effects of device sophistication as a moderator showed a significant positive effect on news and information activity one standard deviation below the mean, $b = .05$, at the mean, $b = .07$, and at one standard deviation above the mean, $b = .10$. Mediation analysis revealed that the indirect effect of income on news and information activity through device sophistication was significant, $b = .06$, 95% CI [.05, .08], acting as a partial mediator. The conditional effects of income on news and information activity were significant and negative at one standard deviation below the mean of
device sophistication, $b = -0.07, t = -3.45, p < .001$. However, they were significant and positive at the mean of device sophistication, $b = 0.03, t = 2.24, p = .02$, as well as for one standard deviation above the mean, $b = 0.12, t = 6.54, p < .001$. Analysis of the simple slopes revealed that the gap in news and information activity between higher paid and lower paid individuals grew as device sophistication increased. The gap in news and information activity among higher paid individuals at different levels of device sophistication also grew as device sophistication increased. However, the opposite happens as income increases for individuals with the lowest rates of device sophistication. In other words, lower income individuals report performing more news and information activities on their smartphones than higher income individuals when device sophistication is low (See Figure 5).
Figure 5. News and information activity significantly increases as people earn more income and have more connected devices; however, activity decreases among higher income individuals that have few devices.

Finally, the interaction between education and device sophistication on social enhancement activity was significant and positive, $b = .13, t = 3.33, p < .001$. The conditional indirect effects of device sophistication on the association between education and social enhancement activity were significant and positive one standard deviation below the mean of device sophistication, $b = .05$, at the mean, $b = .06$, and at one standard deviation above the mean, $b = .07$. Additional mediation analysis revealed that the indirect effect of education on social enhancement activity through device sophistication was significant, $b = .05$, 95% CI [.04,
.07], in this case acting as a full mediator because the direct effect was not significant, $b = -.03$, $t = -1.18$, $p > .05$. A simple moderation analysis showed that the conditional effects of education on social enhancement activity were significant and negative at one standard deviation below the mean of device sophistication, $b = -.10$, $t = -3.15$, $p = .002$. Analysis of the simple slopes showed that for more educated individuals with fewer devices, the gap in social enhancement activity actually reverses such that less educated individuals use the devices for more social enhancement (See Figure 6).

**Figure 6.** Less educated users with fewer devices performed significantly more social enhancement activities on their smartphones compare to more educated individuals. This relationship was not significant for mean access and multi-modal users.
The interaction between education and device sophistication on news and information activity was also significant and positive, $b = .26$, $t = 8.12$, $p < .001$. The conditional indirect effects of device sophistication as a moderator revealed a significant positive effect on news and information activity at one standard deviation below the mean, $b = .04$, at the mean, $b = .06$, and one standard deviation above the mean, $b = .08$. Mediation analysis revealed that the indirect effect of education on news and information activity through device sophistication was significant, $b = .06$, 95% CI [.04, .08], while the direct effect observed in H3 was reduced to non-significance, $b = .04$, $t = 1.87$, $p > .05$; therefore, device sophistication acted as a full mediator.

An analysis of moderation shows the conditional effects of education on news and information activity were significant and negative at one standard deviation below the mean of device sophistication, $b = -.11$, $t = -4.18$, $p < .001$. Additionally, the conditional effects were significant and positive at the mean, $b = .04$, $t = 2.05$, $p = .04$, and one standard deviation above the mean, $b = .16$, $t = 6.66$, $p < .001$. Analysis of the simple slopes revealed that as education increased, the gap in news and information activity grew for those with the mean number of devices and those with multi-modal access; however, news and information activity was significantly lower for higher educated individuals with the fewest devices (See Figure 7).
Figure 7. Each slope represents a significant difference between low and high-educated individuals at different levels of device sophistication. Notice that the relationship reverses for individuals with the fewest devices.

H4 predicted that demographics including (a) race, (b) sex, (c) age, (d) income, and (e) education would be associated with perceptions of smartphone need. Weighted data were used for these analyses. A multiple regression analysis was run to test this hypothesis. All predictor variables were entered in the same block of the regression analysis. This model predicted significant variance in the criterion, $R^2 = .05$, $F(5, 1597) = 15.63, p < .001$. Sex (H4b), $b = .07, t = 2.79, p = .005, r^2_{\text{partial}} = .005$; age (H4c), $b = -.17, t = -7.02, p < .001, r^2_{\text{partial}} = .03$; income (H4d), $b = .08, t = 2.69, p = .007, r^2_{\text{partial}} = .004$; and education (H4e), $b = .07, t = 2.57, p = .01,$
\[ r^2_{\text{partial}} = .004 \], were all significant predictors or perceived need. Women, younger smartphone users, higher income, and more educated individuals perceived greater need in their smartphones. Race, \( b = -.016, t = -.63, p > .05 \) did not significantly predict perceived need. H4a was not significant. It should be noted that analysis of effect sizes indicates that age was by far the most important variable predicting need.

H5 predicted the association between (a) race, (b) sex, (c) age, (d) income, and (e) education and smartphone need would be moderated by device sophistication. This analysis was conducted on unweighted data using a dichotomous device sophistication variable to measure only those users who reported having a smartphone. Specifically, this hypothesis predicted that advantaged demographic groups would perceive more need in smartphone devices because they have more to lose by giving them up, even though they have numerous other Internet connection points.

A moderation analysis was conducted and analyses were run for each demographic factor with each of the remaining factors entered as covariates. The interaction effect of race and device sophistication on perceived smartphone need was not significant, \( b = .125, t = .50, p > .05 \). Therefore this relationship was not analyzed. The interaction effect of sex and device sophistication on smartphone need, approached significance, \( b = .47, t = 1.94, p = .053 \), \( R^2_{\text{change}} = .004 \). The conditional effect of sex on perceived smartphone need was significant and positive for multi-modal users, \( b = .17, t = 3.07, p = .002 \), 95% CI [.06, .28]. Analysis of the interaction indicates that the perception of smartphone need were significantly higher for female multi-modal users compared to male multi-modal users (See Figure 8).
**Figure 8.** Simple slopes for the effect of sex on perceptions of smartphone need at levels of device sophistication. Note that device sophistication is a dichotomous variable: -.5=smartphone-dependent and .5=multi-modal. The marginally significant relationship is observed between male and female multi-modal users. Female multi-modal users perceived significantly more need in their devices.

The interaction effect of age and device sophistication on willingness to give up smartphones was also significant, $b = .015, t = 2.34, p = .019, R^2_{\text{change}} = .006$. The conditional effect of age on willingness to give up smartphones was significant and negative for smartphone-dependent users, $b = -.02, t = -3.39, p < .001, 95\% \text{ CI } [-.03, -.009]$. Likewise, there was a
significant negative effect for multi-modal users, \( b = .006, t = -3.08, p = .002, 95\% \text{ CI } [-.009, -.002] \). So, as age increased, perceived smartphone need decreased for both smartphone-dependent and multi-modal users, but at a steeper rate for smartphone-dependent users compared to multi-modal users (See Figure 9). H5c is supported.

![Graph showing the effect of age on smartphone need at levels of device sophistication](image)

**Figure 9.** Simple slopes show the effect of age on smartphone need at levels of device sophistication. Notice the slope for smartphone-dependent users is steeper and negative.

The interaction effect of education and device sophistication on smartphone need was significant, \( b = .21, t = 2.55, p = .01 \). The conditional effect of education on smartphone need at levels of device sophistication was significant and *negative* for smartphone-dependent users, \( b = -.16, t = -2.02, p = .04, 95\% \text{ CI } [-.32, -.005] \). For multi-modal users, however, there is a
significant positive effect, $b = .05, t = 2.34, p = .02, 95\% \text{ CI } [.007, .085]$. These results showed that as education increased, multi-modal users perceived a greater need for smartphones; however, smartphone dependence reversed this effect (See Figure 10). H5d is supported.

![Figure 10](image.png)

**Figure 10.** Simple slopes for the effect of education on smartphone need at levels of device sophistication. As education increased, multi-modal users perceived a greater need for smartphones; however, smartphone dependence reversed this effect.

The interaction effect of income and device sophistication on smartphone need was not significant, $b = .05, t = .60, p > .05$. H5e is not supported.
H6 predicted that the association between (a) race, (b) sex, (c) age, (d) income, and (e) education and perceived smartphone need would be moderated by smartphone use such that as news and information and social enhancement activity increased, any association between demographics and willingness to give up smartphones would be reduced. Like H5, this analysis was conducted on unweighted data using a dichotomous device sophistication variable to measure only those users who reported having a smartphone. Race was entered as the independent variable, smartphone need as the dependent variable, and social enhancement activity as the moderator. Sex, age, education, and income were entered as covariates. The interaction effect of race and social enhancement on smartphone need was not significant, $b = .04, t = 1.60, p = .11$. The interaction effect of race and news and information activity on smartphone need was also not significant, $b = .06, t = 1.78, p = .074$. H6a is not supported.

Sex was entered as the independent variable with race, age, education, and income entered as covariates. The interaction effect of sex and social enhancement activity on smartphone need was not significant, $b = .03, t = 1.18, p > .05$. The interaction effect of sex and news and information activity on smartphone need was also not significant, $b = .03, t = 1.18, p > .05$. H6b is not supported.

The interaction effect of age and social enhancement activity on smartphone need, however, was significant, $b = .002, t = 2.41, p = .016$. The conditional effect of age on smartphone need at levels of social enhancement activity was significant and negative at one standard deviation below the mean of social enhancement activity, $b = -.005, t = -2.83, p = .005$, 95% CI [-.008, -.001]. Analysis of the simple slopes shows that although among older individuals who performed a high level of social enhancement activity, perceptions of smartphone need rose slightly, the only significant interaction was as people aged and did not
conduct social enhancement activity. In that case, perceptions of smartphone need significantly declined (See Figure 11).

![Figure 11](image)

Figure 11. Simple slopes for the effect of age on smartphone need at rates of social enhancement activity. As people aged and did not conduct social enhancement activity, perceptions of smartphone need significantly declined.

The interaction effect of age and news and information activity on smartphone need was also significant, $b = .002, t = 1.99, p = .047$. The conditional effect of age on smartphone need at levels of news and information activity was significant and negative at one standard deviation below the mean of news and information activity, $b = -.007, t = -4.88, p < .001$, 95% CI [-.11, -.04] and significant and negative at the mean of news and information activity, $b = -.005, t = -$
4.04, $p < .001$, 95% CI [-.08, -.03]. Analysis of the simple slopes shows that older individuals who performed less news and information activity, perceived significantly less need for smartphone devices than younger individuals with low levels of news and information activity (See Figure 12). H6c is supported.

**Figure 12.** Simple slopes for the effect of age on smartphone need at levels of news and information activity. Older individuals who performed less news and information activity, perceived significantly less need for smartphone devices than younger individuals with low levels of news and information activity.
The interaction effect of income and social enhancement activity on smartphone need was not significant, $b = .007, t = 1.38, p = .17$. The interaction effect of income and news and information activity on smartphone need, however, was significant and positive $b = .02, t = 2.51, p = .012$. The conditional effect of income on smartphone need at levels of news and information activity was significant at one standard deviation above the mean of news and information activity, $b = .037, t = 2.80, p = .005, 95\% \text{ CI} [.01, .06]$. Analysis of the simple slopes shows that there was a significant increase in perceived smartphone need for higher income individuals who performed more social enhancement and news and information activity on their smartphones (See Figure 13). H6d is, therefore, partially supported.
**Figure 13.** Simple slopes for the effect of income on smartphone need at levels of news and information activity. Higher income individuals who performed more social enhancement and news and information activity on their smartphones perceived more need.

Both social enhancement activity, $b = .0013$, $t = .16$, $p > .05$, and news and information activity, $b = -.004$, $t = -.46$, $p > .05$, failed to moderate the effect of education on smartphone need. H5e is not supported. For a full breakdown of hypotheses, analyses, and results, see Table 5.

**Discussion**

This study makes several important contributions to digital divide research by focusing on smartphone use. It offers new observations of the knowledge and usage gap frameworks. It also tests the social diversification hypothesis in the context of smartphones using a nationally representative sample of U.S. adults. Four key findings help extend the discussion of Internet inequality generally.

First, these results reinforce the existence of access gaps between demographic groups despite the progress that has been made in addressing phase I of the digital divide. For example, minorities are more likely to be smartphone-dependent than Whites. However, an interesting observation was made showing that minorities also reported having more multi-modal access. The implications of this are discussed below. Second, distinct smartphone usage gaps were observed between demographic groups, showing that Phase II of the digital divide is relevant across Internet connected devices. For example, higher income and higher education levels were positively associated with social enhancement and news and information activities. Third, results help explain why smartphone use differs between demographic groups. For example, limited access plays a mediating role and also moderates the effect of key demographic factors on use.
Fourth, these results help explain how perceptions of smartphone need impact observed use disparities.

The presence of a continuing access gap reinforces the importance of digital divide research. This study shows that demographic groups reported differential access rates to connected devices. Minorities, younger populations, less educated, and lower income groups were more likely to rely on smartphones for Internet access compared to Whites, older, higher income, and more educated individuals. These results support findings that show disadvantaged groups are more likely to have limited access to connected devices (See Lee, Park & Hwang, 2015; van Deursen & van Dijk, 2013, 2014). However, the findings also showed that minorities and younger users reported more multi-modal access than Whites or older individuals. This suggests that these users are adopting mobile technologies faster than their demographic counterparts. There was no significant difference in smartphone-dependence based on sex, which is contradictory to previous findings that show women have fewer devices (Lee, Park & Hwang, 2015; van Deursen & van Dijk, 2013).

Likewise, this study shows that the usage gap extends across Internet connected devices with some notable exceptions. Demographics were associated with types of smartphone use. Specifically, women performed more social enhancement activity on their smartphones compared to men. This finding supports previous research on Internet use trends (See Jackson et al., 2001; Jones et al., 2009; van Deursen & van Dijk, 2013; Zillien & Hargittai, 2009). Minorities, however, performed marginally more social enhancement activity and significantly more news and information activity on their smartphones than Whites. This offers new support for the normalization perspective in the context of smartphone use (See Gonzales, 2015; Mesch, 2012) and also suggests the presence of a reverse usage gap for mobile devices.
Younger people also used smartphone devices more frequently for social enhancement and news and information, which coincides with findings that older individuals are generally less likely to perform online activities such as using e-mail, using search engines, and reading online news (Pearce and Rice, 2013; Wei, 2012). This is likely an artifact of how social enhancement was measured (e.g., asking questions about social media use). Individuals with higher income and higher education were also significantly more likely to perform capital enhancing activities on their smartphones. This finding supports the stratification perspective and prior research showing an income and education-based usage gap (See Zillien & Hargittai, 2009).

This study begins to explain how device sophistication interacts with demographic characteristics to affect social enhancement and news and information activity. Unlike previous studies that have defined multi-modality as number of activities conducted online (Livingstone & Helsper, 2007; Wei, 2012), this study instead focuses on how the number of devices accessible to users impacts their online activities. Results show that when individuals have multiple devices, there is often a “magnifying glass” effect on disparities in smartphone use between and within demographic groups (See Matei & Ball-Rokeach, 2003).

Age was the most significant predictor of smartphone need, which again points out the importance of this particular demographic factor in explaining the digital divide. The types of activities individuals performed on their smartphones also impacted perceptions of need. Older individuals perceived significantly less need in smartphone devices at low levels of social enhancement use. Likewise, older individuals perceived significantly less need in smartphones at low and mean levels of news and information activity. News and information activity also impacted the association between income and need perceptions. Higher income people who used smartphones for average and above average levels of news and information activities perceived
significantly more need in their devices than lower income individuals. The implication is that older individuals get their social support and their news and information from other sources than the Internet. On the other hand, higher income people appeared to perceive smartphones as more effective and necessary tools for news and information consumption.

These findings have implications for both the social diversification hypothesis as well as the knowledge and usage gap hypotheses. As described earlier, the social diversification hypothesis (Mesch, 2012) proposes that Internet access can decrease inequalities through the process of normalization, or increase them through stratification. Normalization happens when disadvantaged groups use the Internet to expand their social networks. Stratification happens when advantaged groups use the Internet for more social enhancement. The knowledge and usage gap hypotheses refer to the use of the Internet for capital enhancing activities (i.e., news and information). The knowledge and usage gap appears when advantaged groups perform more news and information activities (i.e., capital enhancing activities) compared to disadvantaged groups, which can lead to greater inequality through the asymmetrical diffusion of knowledge.

Social Diversification Hypothesis

Differences in social enhancement activities between demographic groups were analyzed to test the social diversification hypothesis. Minorities, women, and younger users performed more social enhancement activities on their smartphones than Whites, men, and older individuals. These findings support the normalization perspective and suggest that smartphone devices are perceived as particularly effective at building social networks. Supporting the stratification perspective, however, results showed that higher income and more educated individuals tended to perform more social enhancement activities on their smartphones.
When these relationships were analyzed in the moderated-mediation model race and sex, two key normalization findings, became non-significant. In other words, device sophistication explains enough variance in the relationship between race and sex and smartphone activities to make the association non-significant when it is included. The implication is that underlying inequalities in access to devices (i.e., device sophistication) is an important factor in use, possibly more important than demographic characteristics. This provides support to the device divide argument because it reinforces the importance of forms of Internet accessibility in the activities we perform online.

Device sophistication also acted as a moderated-mediator between the independent variables of age, income, and education and social enhancement activity. The gap in social enhancement activity between younger and older individuals, as well as among younger users, grew as device sophistication increased. The implication is that multi-modal access has a magnifying effect on the age gap in smartphone use for social enhancement activities as well as on the gap in use among younger users. This finding offers mixed support for the normalization perspective as well as the stratification perspective. Older individuals traditionally report having more social support, so if younger people are using smartphones for more social enhancement, they may be able to close this gap. Conversely, there is a magnified gap among younger people based on device sophistication. In other words, multi-modal access helps to mitigate a possible gap in social capital between young and old (normalization), but increases the gap in social capital among younger individuals (stratification).

Device sophistication also magnified the inequalities in smartphone use between higher income and higher educated individuals. The relationship between income and education and social enhancement activity is magnified as device sophistication increases. So the gap in social
enhancement activity between levels of income and education as well as among income and education levels grows as device sophistication increases. Device sophistication, therefore, acts as a magnifier of inequalities. This finding supports the stratification perspective and offers support for the existence of a device gap. Complicating this finding, however, is the observation that for higher income people with less access the association between income and social enhancement activity became negative. In other words, lower income individuals with fewer devices, actually used them for more social enhancement activity than higher income groups. This finding provides support for the basic tenets of the diversification hypothesis in that disadvantaged groups are using mobile devices in a way that can increase their social capital. Likewise, education was negatively associated with social activity when device sophistication was low. In other words, less educated individuals reported more social activity on their smartphones when they had limited access.

**Knowledge and Usage Gap**

Differences in news and information activities between demographic groups were examined to test the knowledge gap and usage gap hypotheses. Results of this study show that less educated, and lower income individuals reported lower levels of news and information consumption on smartphone devices. This finding supports the basic tenets of the knowledge gap hypotheses, which states that as more information diffuses in a social system the gap between disadvantaged and advantaged demographic groups grows. Again, this exposes a magnifying glass effect of device sophistication on smartphone news and information activity (Matei & Ball-Rokeach, 2003).

The magnifying effect of device sophistication on the association between income and education and news and information activities also has implications for the normalization
perspective. Although higher income people were more likely to perform news and information activity when they had more devices, when they had the fewest number of reported devices, they actually performed less news and information activities on their smartphones than lower income people. The same trend was observed for higher-educated individuals. Less educated users actually used smartphones more frequently for news and information activities.

Counter to the typical expectations, minorities were significantly more likely to use smartphones for news and information activity, which suggests traditionally disadvantaged minority groups may be able to use smartphones to bridge the knowledge gap. Exploring how device sophistication impacts these observations provides additional insight into the device gap. Again, the implication is that underlying inequality in access to devices is an important factor that can change the way individuals perceive and use smartphone devices.

Finally, these results indicate that smartphones have positive implications for some demographic groups and negative implications for others. Minorities and women offer the clearest example of a normalization effect. Minorities performed generally more activities on their smartphones (both social and news/information). Women performed more social enhancement activities on their smartphones. These findings, however, are complicated when device sophistication is accounted for. Overall, device sophistication generally magnified the traditional inequalities between demographic groups observed in this study. The broad implication is that smartphones, rather than helping mitigate inequalities for traditionally disadvantaged groups, often magnify them. These findings support the critique of mobile Internet access made by Napoli and Obar (2015) and indicate the presence of a device gap between and among key demographic groups. Some interesting findings, however, show that traditionally
disadvantaged groups are adopting mobile technologies faster than some advantaged groups. This will have implications for the future as more Internet users move to mobile devices.

**Limitations**

The use of secondary data restricted the creation of more specific measures for items, most notably for smartphone use (both social enhancement and news and information activity). Because of the way Pew conducted the survey and designed some survey items, certain questions were asked of only a subset of the sample, thus, questions had to be left out of the analysis. This had a negative impact on reliability as is apparent in the alphas for the use measures. However, using a nationally representative random sample of U.S. adults allowed for analysis of a novel population, namely smartphone-dependent Internet users. This is a particularly difficult population to identify and survey. Of course, this could also be considered a limitation. The population of smartphone-only users remains relatively small at just 7% of the population (Smith, 2015). The unweighted sample size of smartphone-dependent users was \( n = 55 \) for this study, or about 2.4% of total participants. One of the likely reasons this number does not align with current rates of smartphone-dependent users is that in the time since this data was collected, the number of smartphone users has increased substantially from about 35% in 2011 to about 68% in 2015 (Anderson, 2015).

**Conclusion**

This study contributes to digital divide research by focusing on the under-studied area of differences in smartphone use across key demographic groups. Moving forward, these findings need to be tested in an experimental setting in order to better identify key differences between smartphone, tablet, and PC devices. Specifically, we need to better understand the limitations of different connected devices regarding engagement and knowledge acquisition, among other
outcomes. With mobile handheld devices becoming more prevalent and beginning to outpace the diffusion and use of broadband “wired” devices particularly in developing countries, the implications of this study are particularly important. The concept of affordances could offer further insight into why different demographic groups choose to use smartphones for specific activities (Gibson, 1986). Affordances has been used to study social media (Treem & Leonardi, 2012) as well as Internet use generally (Rainie & Wellman, 2012; Wellman, Quan Haase, Witte, & Hampton, 2001). Determining if different demographic groups perceive different affordances for smartphones would offer additional explanation for the usage gap.
References


Lee, H., & Yang, J. (2014). Political knowledge gaps among news consumers with different


National Telecommunications and Information Administration. 1995. *Falling through the net II: A survey of the “have-nots” in rural America*. Washington, DC: NTIA.


http://dx.doi.org/10.1080/1369118X.2014.994544


<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>IV/Level of Measurement</th>
<th>Interaction</th>
<th>DV/Level of Measurement</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>Age (Ratio), race (Nominal), sex (Nominal), income (Interval), and education (Ordinal)</td>
<td>None</td>
<td>Device Sophistication (Nominal or interval)</td>
<td>Chi Square/t-tests</td>
</tr>
<tr>
<td>H2</td>
<td>Age, race, sex, income, and education</td>
<td>None</td>
<td>Social enhancement activity (Interval)</td>
<td>Multiple Regression</td>
</tr>
<tr>
<td>H3</td>
<td>Age, race, sex, income, and education</td>
<td>None</td>
<td>News and information activity (Interval)</td>
<td>Multiple Regression</td>
</tr>
<tr>
<td>RQ1, RQ2, RQ3</td>
<td>Age, race, sex, income, and education</td>
<td>Device sophistication (moderation-mediation)</td>
<td>Social enhancement and new and information activity</td>
<td>PROCESS moderation-mediation Model 74</td>
</tr>
<tr>
<td>Hypothesis</td>
<td>Analysis</td>
<td>Significant</td>
<td>Not significant</td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>----------</td>
<td>-------------</td>
<td>----------------</td>
<td></td>
</tr>
<tr>
<td>H1: Rates of smartphone dependence</td>
<td>Chi Square/ANOVAs</td>
<td>H1a: Minorities more SP dependent and multi-modal; H1c: Younger users more SP dependent and multi-modal</td>
<td>H1b: Sex</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Independent and dependent variables, levels of measurement, and statistical analyses of each proposed hypothesis and research questions are detailed.

Table 5
<table>
<thead>
<tr>
<th>Demographics</th>
<th>Method</th>
<th>Hypothesis</th>
</tr>
</thead>
</table>
| H2: Demographics associated with social enhancement use | Multiple regression | H2a: Minorities marginally more likely to perform social activities; 
H2b: Women more likely to perform social activity; 
H2c: Younger users more likely to perform social activities 
H2d & H2e: Income and education positively associated with social activity |
| H3: Demographics associated with news and information use | Multiple regression | H3a: Minorities more likely to conduct news and info use; 
H3c: younger users more likely to perform news and info; |
<p>|              |             | H3b: Sex                                                                   |</p>
<table>
<thead>
<tr>
<th>RQ3 (See Figure 1)</th>
<th>Predictor: Demographics</th>
<th>PROCESS Moderated-mediation model 74</th>
<th>H3d &amp; H3e: higher income and education also predicted news and information use.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Social: Younger users were more likely to perform social activities. Gap between young and old grew as device sophistication increased. Also, gap between young with different levels of devices grew; For higher income with multi-modal access, there was a positive association in social activity, but for higher income people with less access the association became negative. <em>Education</em> was negatively associated with social activity when device</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Social: Race, Sex</td>
<td>News: Sex, Age</td>
</tr>
</tbody>
</table>
sophistication was low. So less educated individuals actually reported more social activity when they have limited access.

**News:** Minorities were more likely to perform news activity when they had fewer devices and a mean number of devices; Higher *income* people were more likely to perform news and info activity when they had more devices; however, higher income individuals with the fewest devices actually perform less news and info on their smartphones than lower income people.

*Education* was positively associated with news and info activity at the mean
and for multi-modal users; however, it was significant and negative for limited access individuals such that lower income users actually used them more frequently.

| H4: Demographics associated with smartphone need | Multiple regression | H4b: Women reported higher levels of need.  
H4c: Younger users reported higher levels of need.  
H4d: Higher income reported more need.  
H4e: Higher education reported more need. |
|---------------------------------------------|---------------------|------------------------------------------------|
| H5: Association between demographics and need moderated by device sophistication | Moderation | H5b: Female multi-modal users perceived marginally more need than male multimodal users  
H5c: Perceived smartphone need reduced for both multi-modal and smartphone-dependent |

<table>
<thead>
<tr>
<th>H4a: Race</th>
</tr>
</thead>
</table>
| H5a: Race  
H5d: income |

| H5d: income |
users as people aged, but at a steep rate for smartphone-dependent users.

H5e: As education increased, multi-modal users perceived a greater need for smartphones; however, smartphone dependence reversed this effect.

<table>
<thead>
<tr>
<th>H6: Association between demographics and need moderated by use</th>
<th>Moderation</th>
<th>Social:</th>
</tr>
</thead>
<tbody>
<tr>
<td>H6c: As people aged and did not perform social activity, perceived smartphone need significantly decreased.</td>
<td>Social: Race, sex, income, education</td>
<td></td>
</tr>
<tr>
<td>News:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H6c: Older individuals who performed less news and information activity, perceived significantly less need for smartphone devices than younger</td>
<td>News: Race, sex, education</td>
<td></td>
</tr>
<tr>
<td>Hypothesis</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>H6d: Higher income individuals who performed more social enhancement and news and information activity on their smartphones perceived more need in the devices.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: This table provides a breakdown of hypotheses, statistical analyses, and results.