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ORIGINAL ARTICLE

Bottom-Up Technology Transmission Within Families: Exploring How Youths Influence Their Parents' Digital Media Use With Dyadic Data

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This study investigated the bottom-up technology transmission process in a country with varied levels of technology diffusion, such as Chile. It explored to what extent children teach their parents how to use digital media and proposed a typology of factors related to this process. By relying on a mixed-methods design—which combined interviews with an original survey—and dyadic data, it found that the transmission occurs for all the technologies investigated, although children's influence should not be overstated. This process was more likely to occur among women and people from lower socioeconomic status, and it was also associated with less authoritarian parents and more fluid parent–child interactions.

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Sara[1] is a 50-year-old hairstylist who lives with a 22-year-old son and an 18-year-old daughter in Puente Alto, a lower-middle income district in Santiago, Chile. About 4 years ago she learned how to use the computer and the Internet.

> I got involved in this thing mostly because the kids encouraged me to do it. 'Mom, do it, you can do it,' they used to say. . . . I also wanted to do some research on hairstyles. I took a very short training session in the city mostly to overcome my fears of technology. . . . But my daughter has been my teacher. I always ask her. She also created me a Facebook page and taught me how to use it. . . . Now, I am in contact with a few well-known hairstylists who accepted me as a friend. We can share stuff about work.

This case shows that digital inequality is still associated with factors such as gender, age, and socioeconomic status. However, it also reveals that the younger generation may represent a ray of optimism for including older generations in the digital environment. The younger generation has been raised with a greater familiarity with new technologies than that of their parents or grandparents. Understandably,

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this idea has been criticized for treating young people as a monolithic group with an innate talent for using technology (Herring, 2008; Selwyn, 2009) and for not considering that their digital skills vary widely (see e.g., Correa, 2010; Correa & Jeong, 2011; Hargittai 2010; Livingstone & Helsper, 2007). It is a fact, however, that age remains as the most consistent and enduring digital gap. Teens and young adults are more likely to be online than older generations (WIP Chile, 2011; Zickuhr, 2010). When the computer and the Internet were diffusing, scholars concluded that teenagers were active in teaching and helping older family members learn how to manage these new technologies and eventually became agents of social change within their own families (Kiesler, Zdaniuk, Lundmark, & Kraut, 2000; Wheelock, 1992). Recent studies have also shown that children play a role in their parents' use of the web (Correa, Straubhaar, Spence, & Chen, in press; Godoy & Gálvez, 2011; Ito et al., 2009).

Despite the fact that we see this phenomenon on a regular basis, scant academic research has explored the bottom-up technology transmission process in detail. The majority of the studies have used qualitative methodologies. Despite the fact that qualitative research is useful to comprehend the phenomenon, it is necessary to estimate the effect sizes and systematize the factors that play a role in the process. Although children are one aspect in a complex process where many factors are involved, their potential influence merits more detailed investigations, not only in developed countries like the United States but in countries with varied levels of ICT diffusion. This study explores to what extent youths influence the digital media learning process of their parents (or guardians) and the factors that intervene in this bottom-up transmission. The study was conducted in Santiago, Chile's capital city. This country of 17 million people represents a useful example for studying this process because of its relatively high—but varied—levels of technology diffusion. Almost half (46.8%) of Chilean households have a computer (ITU, 2012) and more than half (58%) of the population uses the Internet (WIP Chile, 2011). Although these penetration rates are among the highest in Latin America (ITU, 2012), there are still wide gaps gauging by age and socioeconomic status (Godoy & Gálvez, 2011; WIP Chile, 2011).

Although family structures have become enormously varied over the past decades (Bianchi & Casper, 2000), for this study, family is defined broadly as members who live or have lived in the same household and have some sort of relation, excluding roommates. Digital media and information and communication technologies are also ever-evolving concepts that include telecommunications, computers, and software programs. Although these systems are a "fluid" array of multipurpose devices and products (Lin, 2003), for the purpose of analyzing the results, they were divided into three clusters: computers (i.e., desktop computer and laptop), mobiles (from basic cell phones to smartphones), and the Internet, which includes Internet applications.

Socialization and domestication theories

The socialization literature recognizes that parents, siblings, teachers, peers, and the media are agents of socialization, but it strongly argues that parents are the

primary agents of influence (Grusec & Davidov, 2007). Although socialization has been traditionally conceptualized as a unidirectional mechanism for reproduction of culture across generations, more current approaches consider this as a more bidirectional process (Kuczynski & Parkin, 2007). Despite the development of this more interactive and complex approach, the literature falls short in exploring in depth how this top-down process can be reversed to a certain extent in more context-specific situations. There is evidence that children can reverse the traditional top-down model of political socialization and influence their parents' acquisition of political knowledge (McDevitt & Chaffee, 2000). Because consumer research suggests that teenagers influence their parents' decisions when they consider that a product is important and are knowledgeable about it (Beatty & Talpade, 1994), one can expect that the traditional top-down socialization pattern can be reversed in the adoption of new technologies.

In the process of technology diffusion, opinion leaders obtain information from diverse sources (e.g., mass media, peers) and then influence other people's behaviors informally in a desired way (Rogers, 1995). They are more exposed to external communication, serve as a point of entry of new ideas into their social system, are accessible by formal or informal discussions, and are more innovative. In the same way, youths have external exposure to digital media through their school and friends, serve as a point of entry for new ideas in their families, are accessible to their parents through face-to-face communication in informal settings (i.e., the household), and are more innovative than their parents (Zickuhr, 2010). Thus, they may act as opinion leaders in their parents' adoption of technology.

Because this study not only explores to what extent youths influence their parents' adoption of new technologies but also the factors that intervene in the process, domestication theory provides a useful framework. This theory (Silverstone, 1994; Silverstone & Hirsch, 1992) considers the context in which new technologies are introduced, particularly in the household. When the technology is being incorporated into the household dynamic, it is important to take into account the moral economy of the household. That is, we must consider the productive and consumptive activities of the household's members, which are defined by the position in the social structure, culture, and values of the household and its members (Silverstone, Hirsch, & Morley, 1992). In other words, it is relevant to account for structural factors, including the household class position, the gender roles, and ages of family members. It is also pertinent to consider the family culture, namely, the politics of the home and the interactions among household members (Haddon, 2006).

Because in the communication literature the term "brokering" has been used as the "way that children facilitate their parents' connection to and understanding of traditional and new communication technologies" (Katz, 2010, p. 299), "technology broker" is an appropriate label for the process in which children mediate between their parents and digital media.

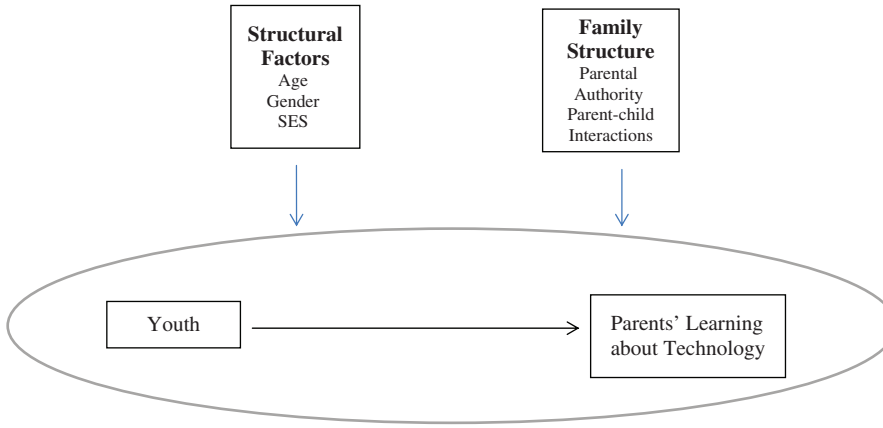

Figure 1 Visual representation of typology of factors related to youths' influence on parents' learning about technology.

Bottom-up technology transmission

On the basis of the theoretical framework and previous literature, it is hypothesized that youths influence their parents' learning of new information technologies, defined as computers, mobiles, and the Internet. The research question is to what extent do youths influence their parents' learning of new technologies? Domestication theory and the moral economy of the household also suggest that this bottom-up influence process is more (or less) likely to occur depending on the context, such as structural factors and family culture (see Figure 1).

Structural factors

Youths' age

Diffusion research argues that opinion leaders have to develop rapport and credibility to convince their followers (i.e., parents) (Rogers, 1995). Because adolescents are more likely to use more sophisticated persuasive strategies than younger children (Palan & Wilkes, 1997), older children are more likely to influence their parents (Buijzen & Valkenburg, 2008). In addition, older adolescents are more likely to have acquired experience and skills regarding technology. Thus, it is hypothesized that the older the children, the greater their influence on their parents' learning of new technologies.

Gender roles

As domestication theory (Silverstone & Hirsch, 1992) as well as research on gender and technologies (Wheelock, 1992) suggest, the incorporation of information technologies into the household is shaped by gender roles. People have been socialized with the idea that technology is a male domain (e.g., Cooper, 2006; Dholakia, Dholakia, & Kshetri, 2004). As a result, husbands and sons are generally in charge of communication technologies at home and women would prefer to stay away from

operating technologies to avoid additional home responsibilities or challenging gender relations (Ribak, 2001). In this sense, the literature has found gender differences in the level of influence youths exert on their parents' technology usage. For instance, scholars have found that boys were more likely than girls to help both parents to use the Internet. They have also found that many fathers expressed uneasiness when they had to rely on their children to use the computer (Ribak, 2001) and resisted help from their daughters (Kiesler et al., 2000). By way of contrast, although mothers sometimes showed distress (Fortunati & Taipale, 2012) and were often described by children as "clueless" regarding technologies (Horst, 2009), they were more likely to receive help from their children (Correa et al., in press; Wheelock, 1992). Compared to fathers, who expressed uneasiness and resentment, mothers showed pride and appreciation for their children's assistance (Ribak, 2001). Therefore, it is hypothesized that boys will be more likely than girls to influence both fathers' and mothers' technology learning. It is also proposed that mothers will be more likely than fathers to be influenced by their children in the learning of a new technology.

Family SES

In families from a lower SES, youths may act as key brokers between the family and the outside environment (Kam, 2011; Katz, 2010). Similar to what happens with language and culture among low-income immigrant families, where children act as links between their families and the new environment, youths from a lower SES have greater exposure to new technological ideas through their school and friends. Furthermore, scholars suggest that young people from disadvantaged environments have more egalitarian parent–child relationships and assume adult responsibilities at a younger age (e.g., Brown, Bakken, Nguyen, & Von Bank, 2007; Burton, Allison, & Obeidallah, 1995). Also, families that share nonwestern values perceive brokering activities as a natural contribution to the family (Kam, 2011). Thus, both qualitative and quantitative accounts have reported that youth play a key role in their parents' usage of new technologies among low-SES families (Correa et al., in press; Straubhaar, Spence, Tufekci, & Lentz, 2012; Tripp & Herr-Stephenson, 2009). Therefore, it is hypothesized that youths' influence on parents' learning of new technologies will be stronger among lower-SES families than higher-SES families.

Family culture

Parental authority

When the technology is being domesticated, Katz (2010) found that retained parental authority can positively influence children's technological mediating activities, while family instability constrains the influence. Further, Kiesler et al. (2000) found that the potential inversion of authority was one explanation that fathers gave for resisting help from their children in using the web. Similarly, Ribak (2001) showed that technology dependence breaks family hierarchies, which challenges parental authority and social order.

In child development research, parental authority is investigated with regard to two dimensions: responsiveness/involvement and strictness/control

(Baumrind, 1991). The former describes parents who are attuned to and supportive of their children's needs, while the latter describes parents who supervise, apply discipline, and confront disobedient children (Baumrind, 1991). Authoritarian parents are characterized as having high levels of control and low levels of warmth. These parenting styles vary by culture and socioeconomic context (Brown et al., 2007; Darling, Cumsille, & Peña-Alampay, 2005). Although it is expected that families in mostly Catholic, Latin American countries, like Chile, are more likely to adhere to conservative values and have interdependent orientations, Chilean families have changed enormously in the last 2 decades due to single-parenting, increasing cohabitation, and female-headed households (Salinas, 2011). A cross-cultural comparison among Chilean, United States, and Filipino families found that Chilean and U.S. parents were less likely to exercise control through rules and youth felt less obliged to obey them than in the case of their Asian counterparts (Darling et al., 2005). Thus, the more authoritarian the parents, the less influence youths will have on their parents' learning of digital media.

Child–parent interactions

Because the diffusion literature suggests that opinion leaders have to be accessible to influence the followers (Rogers, 1995), one factor that may intervene in the bottom-up technology transmission would be the level of interaction between parents and children. Parent–child interaction is a facilitator of family cohesion (Barnes & Olson, 1985). For example, research on intergenerational communication has found that youth tend to accommodate to older people's needs when they were perceived as supportive and encouraging to young people (Williams & Nussbaum, 2001). In the digital realm, when parents and children had trusting and positive relationships, young people were more open about their digital activities (Clark, 2009). If parents and children have a greater interaction and are accessible to each other, children would have more chances to transmit their digital expertise, and parents would be more willing to be exposed to these new ideas. Therefore, youths who have greater interaction with their parents will have greater influence on their parents' digital media learning.

Methods

To investigate the influence exerted from children to parents in digital media learning, this project relied on a sequential mixed-methods research approach and dyadic data. It combined in-depth interviews with a self-administered paper-and-pencil survey conducted in Chile. On the basis of Creswell and Plano Clark's (2007) mixed-methods typology, I used an exploratory research design, which is characterized by an initial phase of qualitative data collection followed by quantitative data gathering. In this research project, the qualitative exploration was performed first by interviewing young children and then their parents or guardians separately, from different socioeconomic backgrounds. The interviews provided access to the participants' digital experiences and allowed for an exploration of their

Table 1 Stratification of Interviews' Sample

	Age		Socioeconomic Status			
	12–14	15–18	Lower	Middle	High	Total
Mother/female guardian	N/A		4	2	2	8
Father/male guardian	N/A		1	3	2	6
Son	4	3	4	1	2	7
Daughter	3	4	1	4	2	7
Total						28

feelings and beliefs as well as more private issues (Bauer & Gaskell, 2000; Rosenblum, 1987), such as family interactions. This exploratory qualitative inquiry also helped in creating a more valid and reliable survey instrument, because it provided insights regarding the conditions that made the child–parent influence more likely. Finally, it revealed hints on the language used by parents and youths to talk about these topics. The data gathered through the interviews was also used to better explain the survey results. Particularly, the narratives provided voice and meaning to the survey results and a "fine-textured understanding" of the social phenomenon under study (Bauer & Gaskell, 2000, p. 39).

Interviews

Participants

In the first phase of the study, 28 semi structured in-depth interviews involving one 12- to 18-year-old child and one parent or legal guardian who lived with the child (14 dyads in total) were conducted separately in Santiago during September and October of 2011. In the selection process, a stratification of people from different socioeconomic backgrounds, ages, and genders was considered (see a description of the sample in Table 1). In this phase, children's type of school (public, semiprivate, and private) was used as a proxy for interviewees' SES. In Chile, public schools serve low-income populations, semiprivate schools concentrate on lower-middle and middle-income groups while private-paid institutions cater to the wealthiest sectors of the population (Torche, 2005).

Procedure

For the recruitment process, a snowball sampling method was used, starting from acquaintances who recommended more possible interviewees. The interviews were recorded and lasted about 1 hour. Some of the topics that were covered in the interviews were relationships with and level of usage of digital media, perceived influence of children in acquiring and learning how to use these tools, other sources of learning inputs, and family relationship and interactions. Interviews were conducted until no new information emerged and the themes were considered saturated.

The 28 interviews were transcribed and textually analyzed, searching for common and new themes and paying attention to the language and topics that had not been foreseen by the literature and the theory. For instance, they revealed that people distinguished among basic cell phones, touch cell phones, and smartphones. Also, besides dial-up, broadband, and WiFi, a fourth type of Internet connection, mobile broadband through USB modem, was commonly used in Chile because of its ubiquity and affordability. Finally, they showed how families negotiated authority and parent–child exchanges in contexts where the traditional top-down socialization was being challenged.

Bottom-up technology transmission survey

Participants

In the second phase of the study, a parent–child dyad survey was conducted among both school-aged children (from 12 to 18 years old) and their parents or guardians about technology usage. The data were collected in three schools in Santiago, Chile, during November of 2011. School-aged students were reached through their schools and the questionnaires were administered during regular classroom hours. Three coeducational schools that included at least the last 2 years of middle school education (7th and 8th grades) and full secondary education (9th to 12th grades) were chosen. Following a stratified sampling method, the survey was conducted in a private-paid school located in a high-income area, a semiprivate school in a middle-income area, and a foundation-owned school that targets disadvantaged populations in a low-income district.

Procedure

Within each school, one class per cohort was randomly chosen. As a result, five classes per school were surveyed (from 7th to 11th grades).[2] Each student answered a paper-and-pencil questionnaire during school hours. Then each student received one extra paper-and-pencil questionnaire to be completed by one parent/guardian. The children's and parents' surveys had the same ID number to facilitate the identification of the dyad. The children received an incentive if they returned the parents' questionnaires. All of the children who were in class at the moment of the data collection responded to the survey. In total, 381 children and 251 parents completed the survey, leading to a parents' response rate of 66%. Of the completed surveys, 242 child–parent dyads were useful for the dyadic data analysis.

Since both parents and children were surveyed in this project, in some data analyses both parents' and students' data was employed. However, most statistical examinations are based on dyadic data analyses, which imply using the parent–child dyad as the unit of analysis (Kenny, Kashy, & Cook, 2006). In this study the individuals belonged to only one dyad, and thus, a standard dyadic design was used. That is, both persons were measured, and for some factors, both were measured on the same variables, which increased the validity and reliability of the results, because dyadic analyses provide two observations to explore one construct. Following common

dyadic analysis (Kenny, Kashy, & Cook, 2006), the nonindependence level among distinguishable dyads such as parent–child was measured with Pearson *r* correlation. Then, for the general analyses, it was necessary to create a dyadic dataset with dyadic variables by computing the average of each member score in the variable of interest. After conducting this procedure, which corrects for nonindependence of errors, the regression analyses were conducted as usual.

Measures

Youths as brokers in technology learning

To investigate to what extent youths have influenced their parents' learning of new technologies by teaching them how to use technologies, parents were asked about the influence of "their children in general." To create the dyadic variable, parents were also asked about "only the child who is answering the survey at school." And in the youths' survey, wording of the question changed accordingly.[3] The response categories run from 1 ("not at all") to 5 ("a lot"). There was also an option "I don't have it," with a corresponding score of 0. Three different dependent variables were created: (a) influence on computer learning, (b) influence on mobile learning, and (c) influence on Internet learning. In both the parents' and children's samples, the adoption of desktop computers versus laptops as well as the different mobile devices was, in many cases, mutually exclusive.[4] In addition, theoretically, this study wanted to measure youths' influence on computer or mobile learning (either desktop or laptop and either basic cell phone, touch cell phone, or smartphone). Thus, to create these dyadic dependent variables, the highest value between either influence on "desktop computer learning" or "laptop computer learning" was chosen. Also, to compute mobile learning, the highest score among either influence on "basic cell phone learning," "touch cell phone learning," or "smartphone learning" was chosen. Then, the scores from both parents' and children's samples were averaged (influence on computer learning: $r = .47, p < .001, M = 3.31, SD = 1.06$; influence on mobile learning: $r = .21, p < .01, M = 2.98, SD = 1.06$). Finally, "influence on Internet learning" was created from a scale that averaged four dyadic variables—influence on learning Internet in general, e-mail, uploading files, photos, and videos, and social media. Each dyadic variable was created by averaging both parents' and children's scores ($\alpha = .84, M = 2.19, SD = .97$).

Structural factors

Age was measured as a continuous variable.[5] Gender was dummy coded. Socioeconomic status was measured by an average of parent's education and family income. For education, parents were asked: "What is the highest degree or level of school you have completed?" There were nine response categories from incomplete primary to graduate degree. For family income, they were asked: Thinking about your income and the income of everyone else who lives with you, what was your total household income in a typical month over the past 12 months? The options were divided into 11 categories that ranged from "less than $100,000 pesos (less than US$200)," to

"more than $4,000,000 pesos (more than US$8,000)." These variables were first standardized and then averaged.[6] Employment status and marital status can also play a role in the influence youths may exert on their parents. For example, homemaker parents can spend more time with their children, and separated or divorced parents may need to use technology devices more often to communicate with their children. Thus, both variables were included as control.

Parental authority

Scales of strictness/control and responsiveness/involvement were used to measure parental authoritarianism (Steinberg et al., 1994). The items selected to measure each parenting dimension are based on different scales devised to measure this variable (Reitman, Rhode, Hupp & Altobello, 2002; Smetana, 1995; Steinberg, Lamborn, Darling, Mounts & Dornbusch, 1994). With a 5-point Likert scale, parents had to rate three items that represented control and four items that represented involvement. Examples of strictness/control items were: "When I ask my children to do something, I expect it to be done immediately, without question," "I don't allow my children to question the decisions I make." Regarding involvement items, some examples were: "My children count on me to help them out if they have some kind of problem," "When I want my children to do something, I explain why." Because authoritarian parents have high levels of control and low levels of warmth, the involvement scale items were reversed and then averaged with the control items to create a scale of parental authoritarianism ($\alpha = .65$; $M = 2.25$, $SD = 2.28$).[7]

Child–parent interactions

On the basis of research about parent–child relationships (Eron, 1982; Sieving, McNeely, & Blum, 2000), this variable was measured as accessibility, closeness, and open communication. This variable was measured for both parents and children, and parents were asked to think about the specific child who was answering the survey at school. With a 5-point Likert scale, both parents and children were asked to rate four statements, which were averaged on a scale. Examples of parent–child interaction items were the following: "We spend a lot of time talking, playing, and/or doing sports," "Overall, I am satisfied with the communication I have with my child (parents)." Because parents' and children's answers were significantly correlated (Pearson's $r = .39$, $p < .001$), which suggested nonindependence, a dyadic variable of parent–child interaction was created ($\alpha = .86$, $M = 3.5$, $SD = .76$).

Results

The interviews' sample differed by age, gender, and SES (see Table 1). In the parents' survey sample, of the 251 parents who completed the survey, 63% were women and 37% were men. Their ages ranged from 28 to 74 with a mean age of 44 years. On average, parents had completed technical/professional education, which is similar to

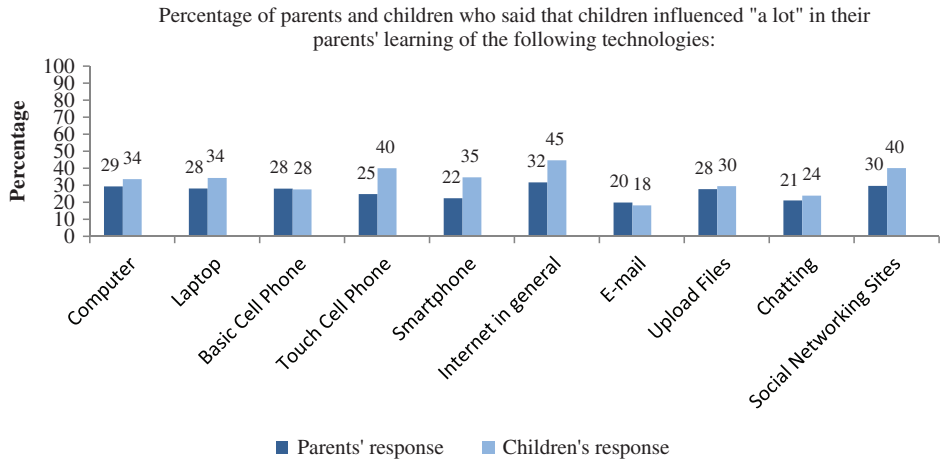

Figure 2 Youths' influence on parents' technology learning percentage comparison.

an American 2-year college ($M = 5.51$, $SD = 2.15$), and their family income ranged between US$1,000 and US$1,500 on a monthly basis ($Mdn = 6.00$, $SD = 3.13$). Most parents were married (75%) and employed full-time (55%), although one-fifth were homemakers. Of the 381 students who answered the survey, 52% were women and 48% were men. Their mean age was 15 years ($SD = 1.57$).

Youths' influence on technology learning

The quantitative analyses about youths' influence on their parents' technology learning revealed that children played a role in all the technologies investigated in this study. They also showed a consistent pattern: Children said they had a greater influence on their parents' technology learning than did their parents. In all of the technology categories, the children's scores were higher than their parents' scores (see Figure 2). One possible explanation for this disconnect that consistently emerged in the interviews is that the children considered that they taught their parents, but their parents did not recognize this influence or considered that their children's effort was not sufficient. For instance, Emilia was a 13-year-old girl who attended a semiprivate school. Her 36-year-old father described himself as fairly tech-savvy and said that he has never been taught by his daughter. However, she explained that she has tried to teach mobile gaming to her father.

> "He didn't know where to find games in my mobile. So, I told him 'Here, then here, and here.' Then, he asked 'but set it up,' 'But I already taught you,' 'No, you didn't.' Then (talking slowly) I had to say, 'You click here, you open the window, you start playing and the game appears.' He eventually got it."

Other children consistently said that they had tried to teach their parents or guardians but they "forget" or parents were described as a "lost cause." For example, Joaquin, the 16-year-old son of Teo—a 48-year-old warehouse supervisor in a

Table 2 Factors Related to Youths' Influence on Their Parents' Technology Learning

	Youth Influence on Computer Learning Beta	Youth Influence on Mobile Learning Beta	Youth Influence on Internet Learning Beta
Control variables			
Parent's employment status (1 = homemaker)	.04	.01	−.12†
Parent's marital status (1 = separated/divorced)	−.05	.03	−.03
Structural variables			
Youth's age	.09†	.20**	.07
Youth's gender (1 = woman)	−.01	−.14*	−.03
Parent's gender (1 = woman)	.11*	.10†	.22**
Socioeconomic status	−.42***	−.09	−.09
Family structure			
Parent's authoritarianism	−.13*	−.08	−.10†
Dyadic parent–child interaction	.06	.12*	.04
R^2	20%***	11%**	7%†
N	196	185	192

†$p \leq .10$, *$p \leq .05$, **$p \leq .01$, ***$p \leq .001$ (one-tailed).

medium-sized company—said that he taught his father how to edit photos because his father loves taking pictures, but when Teo was asked, he said he did not know how to edit photos in the computer.

Factors related to technology transmission

Structural factors

The regression analyses showed that the four structural variables were significantly associated with youths' influence on parents' technology learning in the predicted direction (see Table 2). First, youths' age was positively related to parents' mobile learning and to computer learning. That is, the older the children, the more likely they were to teach their parents how to use mobiles and computers. Also, boys were more likely than girls to teach their parents how to use mobiles and mothers were more likely to be taught by their children how to use computers, mobiles, and the Internet. Finally, youths from lower-SES families were more likely to teach their parents how to use computers. The relationships between family SES and influence on mobile and Internet learning were nonsignificant, although negative.

In the interviews' analyses, the two most evident phenomena were that mothers, rather than fathers, were more likely to be taught by their children, and that the

bottom-up teaching transmission was stronger among middle- and lower-SES families. In the interviews, only male parents said that they did not require help from their children. When the father did not rely on his child because he considered himself to be fairly tech-savvy, the children said that they helped the mother, and mothers appreciated this help. For example, Manuel was 32 years old, had completed his high school education and had taken some classes in electronics. Although he had only one desktop computer at home located in the dining room, he felt competent with technology. Thus, his 12-year-old daughter has taught her mother how to turn on the computer and download music. This phenomenon was also evident in a tech-rich family. The Garcías were an upper-class family with three children—one 21-year-old man and two girls who were 13 and 23 years, respectively. The men of the family were Apple fans. Although the father had not been taught by his children, the interviews revealed that the children have taught their mother, who had been reluctant to use digital media. "She used to use a basic cell phone, but when the kids, especially the boy, showed her the iPad, she got crazy. She didn't know it was so user-friendly," said the father. Thus, the children created an e-mail account for her a couple of months before the interview was conducted and now she was using an iPhone. In a lower-SES family who lived as nonrenters with the grandparents in a poor neighborhood, the children had introduced their homemaker mother to digital media through Facebook. "It's been hard for me to learn to use the computer. The kids used to teach me. But since I learned Face(book) I chat with my sister-in-law, and . . . play games. . . . I use Facebook to entertain myself, to unwind," said the mother.

Although the bottom-up teaching transmission occurred across social classes, it was more evident and meaningful among the lower classes. While in middle- and upper-SES families children taught their parents to some extent, fathers were not as receptive to their children's input as in families from the lower classes. Also, there was more evidence of top-down influence. In higher-SES families, parents tended to learn from a combination of experiences and were more willing to self-experiment with technology. In lower-class families, on the contrary, children played a more central role in their parents' learning experiences, and the discourses that described how youths taught their parents were more pervasive. In a lower-income family where the mother was the head of the household, they did not have a computer at home. The son used the cybercafe to do homework and described himself as having lower technology skills compared to those of his classmates. Despite this tech-poor environment, he had taught his mother how to use cell phones, which was highly useful for her work as a sales representative for Avon Cosmetics. This was also the case for Sara, the hairstylist mentioned in the introduction, who described her daughter as "her teacher." Thanks to the Internet, she learned new hairstyles and through her Facebook account she met other colleagues. Finally, a divorced mother of four children said that her children have helped her "more than anything."

Family culture

The regression analyses showed that parents' authoritarianism was negatively related as an influence on both computer and Internet learning. In addition, parent–child interaction was positively associated as an influence on mobile learning. Although the relationships with computer and Internet learning were nonsignificant, they were also positive (see Table 2). Both cases emerged in the interviews: In the dialogs with the dyads where the parent, particularly the father, did not receive help from his children, either the parent or the child said that they did not have good communication or that the father was somewhat controlling. For instance, Martin, the logistics manager of a retail company, said that he was not taught by his children, and his youngest son agreed. The 14-year-old son said that he mostly taught his mother to manage technologies, but not his father. When asked about their interactions, his father said, "(Our communication) could be better. . . . I wish we had more topics in common and more interactions." In a separate interview, his son agreed. When asked about their communication and interactions, he said, "he is a bit difficult. Things have to be done as he says." Similarly, the 17-year-old daughter of a computer engineer said, "I can teach my mom a lot of things. My dad doesn't allow me to." In the García family, where there was no bottom-up transmission between the father and the teenage daughter, the father described the communication pattern with his daughter in the following way: "I'm dissatisfied (with our communication). Generally, she is open with the rest but very reserved with me. It's hard for me to listen to her. . . . Generally, I'm more authoritarian with her." Conversely, the hairstylist mother who has received help from her children described a close relationship with them. They interact over lunch every weekday and on weekends. "(With my daughter) we talk a lot about personal stuff. Same thing with my son." The conversation with her 18-year-old daughter also showed hints of a warm, yet respectful, relationship. "Sometimes I say 'how boring to teach my Mom,' but I must have the will to do it because she taught me other things. I can't complain."

Discussion and conclusion

This project focused on the bottom-up technology transmission process, and investigated how youths teach their parents to use digital media by proposing a typology of factors that may intervene in the process. These factors included structural variables (i.e., age of youths, gender of youths and parents, and family SES) and family culture (i.e., parental authority and parent–child interactions). Because it is appropriate to investigate processes of technology transmission in contexts with wide-ranging levels of technology diffusion, where it is possible to find people who are in the lower and higher ends of technology adoption and usage, this project was conducted in Chile.

The analyses of the results suggested that, in general, there is a bottom-up technology transmission at some level for all of the technologies examined in this

study. Because digital media are ingrained in our daily life, this reverse pattern of influence may increasingly challenge the established models of diffusion where opinion leaders have more authority and seniority within the network (Rogers, 1995) and alter traditional top-down patterns of socialization within families. Therefore, this bottom-up process merits particular attention and investigation. In technological contexts, young people can exert a bottom-up influence—and become opinion leaders—because they have the knowledge (Beatty & Talpade, 1994), are exposed to external inputs about digital media through their school and friends, and are accessible to their parents. This result may even open up the question about the extent to which this reverse influence may modify traditional family roles and social orders in other contexts. At the same time, the children's influence should not be exaggerated because the interviews revealed that parents also learned through other inputs, including self-experimentation and a few of them through short training workshops, which helped them to overcome their fears about technology.

Interestingly, the quantitative assessments showed that children felt more influential about their parents' learning process in comparison with their parents' judgments about their influence. These consistently different assessments confirmed the importance of doing dyadic analyses—which averaged both parents' and children's self-reports—and the interviews helped us to understand these discrepancies. Children tried to teach their parents, but their parents, particularly the fathers, did not recognize this influence or considered that their children's efforts were not adequate. Mothers, on the other hand, valued their children's help. As previously asserted, when new technologies are being adopted within the household, it is relevant to consider the moral economy of the household, being the household's structure, culture, and values (Silverstone et al., 1992). This result shows how the domestication of digital media is shaped by gender roles. Because technology has consistently been associated with men (e.g., Cooper, 2006), studies have found that husbands and sons are the ones who operate communication technologies at home (Ribak, 2001). Therefore, this study confirmed the trend in which boys were more likely than girls to help both parents to use digital media. This gendered approach to technology also sheds light on why fathers were less likely to be taught by their children, resisted help from their children, or did not acknowledge that they had been assisted by their children, as previous studies had found (Correa et al., in press; Godoy & Gálvez, 2011; Kiesler et al., 2000; Ribak, 2001).

Another important finding of this project is the role played by family SES in the bottom-up technology transmission process. The household's class position structures how new technologies are domesticated (Haddon, 2006). Research has found that in underprivileged environments children assume greater responsibilities when they are young, and parents tend to have a more egalitarian relationship with their children (e.g., Brown et al., 2007). Furthermore, among low-income immigrant families, children act as culture and language brokers between the family and the new environment (Kam, 2011; Katz, 2010). Because in this case technology tends

to represents new environment for lower-SES groups/families, youths from poorer families were more likely to receive input about technology from their school and their friends and then spill over this input with their families than was the case with young people from more well-to-do environments.

The fact that this bottom-up technology transmission occurs more frequently among lower-SES families, even when it has been examined using diverse methodologies across different cultures (Correa et al., in press; Katz, 2010; Straubhaar et al., 2012; Tripp & Herr-Stephenson, 2009), has important implications. Poor people usually lag behind in the adoption and usage of technology (e.g., Cho et al., 2003; Livingstone & Helsper, 2007; WIP-Chile, 2011). Many times, they do not have the means to acquire new technologies but, most importantly, they are less likely to have the knowledge, skills, perceived competence, and positive attitudes toward digital media (e.g., Hargittai & Hinnant, 2008; van Dijk, 2005). Although this digital exclusion is somewhat reproduced across generations, because parents would transmit their technology capital and dispositions to their children (Straubhaar et al., 2012), intergenerational socialization is not totally unidirectional and deterministic (Kuczynski & Parkin, 2007). Among lower-income families, parents' social networks are less likely to have ample access to new technologies. Thus, children's external agents of socialization such as peers and schools may become key factors influencing youths to the extent that they may alter traditional family socialization patterns. This result suggests that schools in lower-income areas should be especially considered in government or foundation-led intervention programs that promote usage of digital media. These results are also meaningful because women, particularly older women, tend to lag behind in technology adoption and usage (e.g., Cooper, 2006). Thus, the bottom-up technology transmission may serve as an opportunity for people who suffer ''triple technology jeopardy'' from being women, older, and poorer.

Youths' age also played a role, although not as important as was anticipated. Based on diffusion and consumer research (Palan & Wilkes, 1997; Rogers, 1995) one may conclude that older children have more seniority, experience, skills, and credibility and use sophisticated strategies to have greater influence on their parents' learning process. However, the interviews did not show a clear trend. Thus, one can conclude that there was some evidence that influence increased with age but children who are 12 years old and above may be sophisticated enough to be able to teach their parents how to use technologies.

The survey results showed a negative association between authoritarianism and technology transmission, whereas there is a positive connection between parent–child interactions and technology transmission. In other words, a household where parents show higher levels of involvement and are more accessible and communicative fosters parents' digital inclusion.

Although one may argue that in Latin American countries that tend to hold more conservative values, children may tend to conform to family rules, Chilean family structures and values have deeply changed in the past 2 decades. In fact, cross-cultural

research has found that in Chile and the US, parents were less likely to enforce rules and young people felt less obliged to follow them than in Asia (Darling et al., 2005). These more egalitarian interactions may foster bottom-up technology transmissions, and, as the results suggested, a more controlling and distant relationship may hinder children's influence.

Interestingly, the interviews showed how the family's structure and culture are intertwined in the technology domestication process. Authoritarian fathers seemed less likely to recognize or value their children's assistance. As other scholars (Kiesler et al., 2000; Ribak, 2001) have suggested, the potential dependence on technology alters traditional gender roles, family hierarchies, and social order. It is also possible that the potential inversion of authority may shed light on why parents tended to downgrade youth's influence on their technology learning. On the other hand, mothers, particularly those who were more connected and involved with their children, showed appreciation for their children's help. These traditional gender and authority roles may be a reminiscence of a traditional society. In addition, this bottom-up transmission is more likely to occur among lower-SES families in Chile, not only because children represent a brokering opportunity and a point of entry of new ideas into the family, as diffusion research suggests, but also because parent–child relationships in lower-SES contexts tend to have more egalitarian interactions (e.g., Brown et al., 2007).

The results of this project were strengthened by the usage of a mixed-methods approach and dyadic data analyses. The sequential mixed-method research design (Creswell & Plano Clark, 2007) that combined dyadic in-depth interviews with a dyadic survey was a powerful mixture that allowed the investigation of the bottom-up technology transmission process in a more profound and replicable way. Although the mixed-methods research approach is becoming more popular among scholars, many times quantitative and qualitative results are reported and interpreted separately (Creswell & Plano Clark, 2007). In this study, both approaches were closely intertwined. The parent–child interviews allowed for the creation of a more reliable and valid survey, and helped in explaining the survey results by providing narratives and images. The analyses and conclusions of this study were also bolstered by the usage of dyadic data. This study not only interviewed and surveyed parent–child dyads but also conducted dyadic statistical analyses, which combined each parent's and child's assessments. The dyadic interviews captured dynamics and problems that could have not been assessed if I had relied on one informant only, such as possible explanations for the consistent different assessments parents and children made about youths' influence on parents' technology learning. The survey's dyadic analysis allowed the reduction of measurement error. By surveying both the parent and the child on the same questions, two observations were obtained to measure key variables.

Despite relying on mixed-methods and employing dyadic data, this research study used cross-sectional data to answer questions about a transmission process, which implies changes over time. The interviews, the dyadic self-reports, and the regression

analyses provided more accurate measures and helped interpret cross-sectional data. Additionally, although the sample design was nonprobabilistic, it was relevant for this study because the main purpose was to establish how the bottom-up technology transmission occurred rather than to investigate to what extent this process is present in the population. Still, the stratified sampling method provided a more diverse sample. Future research should try to infer causal relationships by using panel data or quasi-experimental data. For instance, students who participate in a digital media literacy program and their parents should be compared with other equivalent student–parent dyads who did not attend the program. In addition, both groups should be observed and measured in two time periods to detect trends. The results of this study also suggested that gender is a variable worth exploring in more detail. Although this study was not about the gender divide in technology, the interviews revealed wide gender gaps. For example, the interviews revealed gender solidarity; daughters were more likely to teach their mothers while fathers resisted help from their children, particularly daughters. Future research should explore these findings in more depth. Finally, because the main focus was to investigate the bottom-up technology transmission and the factors that intervene in the process itself, future investigations should pay more attention to the effects of the bottom-up transmission process, including increased perceived competence and esteem, possible increases in social capital, civic engagement, life satisfaction, and the potential reduction of digital gaps.

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Notes

1 The interviewees' names were changed for confidentiality.
2 Because the survey was conducted 3 weeks before the national standardized test for college admission, 12th graders were not in school, and were excluded from the sampling frame.
3 Parent survey: Sometimes children teach their parents to use new technologies in various ways: teaching them to set it up, solving a problem, or showing how different applications work, so their parents or guardians can learn. If you think about your children in general/only the child who is answering the survey at school, to what extent have your children taught you to use the following technologies and applications where 1 means "not at all" and 5 means "very much"? Youths' survey: (. . .) If you think about your parents or guardians, to what extent have you taught them how to use the following technologies . . . ?
4 For example, 21% of the parents and students had either a desktop computer or a laptop but not both. Also, in 47% of the sample (114) cases, the adoption of mobile devices was mutually exclusive. Therefore, they scored 0 in either the variable "influence on desktop computer learning" or "influence on laptop learning." If the scores of both variables

would have been averaged, the mean of ''influence on computer learning'' would have been artificially deflated by including the scores of people who actually did not have the technology. If those scores would have been converted into missing values, the sample would have lost 50 of 242 cases.

5 In the parents' survey, 10 missing cases were replaced by the mean (44). In the students' sample, five missing cases were replaced by the mean (15). The median ages were also 44 and 15, respectively.

6 Thirty-three missing cases for income and eight missing cases for education were replaced by the median and mean, respectively (this value was 6.0 in both cases).

7 Although the alpha coefficient is somewhat lower compared to the standard threshold of .70, these items had been previously tested (Reitman et al., 2002; Smetana, 1995; Steinberg et al., 1994). Also, content and face validity were maximized over internal consistency, as previous studies have done (e.g., Booth & Johnson, 1988; Keyes, Shmotkin, & Ryff, 2002). Finally, the risk of lower reliabilities is that the scale may not correlate with other variables, but this was not the case. Therefore, this scale may still be used with some confidence.

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