Opportunities via Extended Networks for Teens' Informal Learning

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ABSTRACT

With the increasing use of the Internet and social media for knowledge and social connections, we might expect that people more easily expand their opportunities for new learning through social relationships online. Yet, this mixed methods study of teens' use of technologies (e.g. YouTube and social media) in informal learning contexts reveals that, in teens' preferred learning activities, few interact with new ties outside their *immediate networks* (school, family, and friends). Given the value of social interaction and weak ties for learning new knowledge, this research investigates teens' use of networked technologies with people and resources outside their immediate networks. Based on 23 semi-structured interviews, we describe teens' informal learning activities and technology practices, from which we identify design opportunities. To inform these, we examine teens' paths into extended networks, including the role of digital skills, technology access, intrinsic motivation, and sense of relatedness. We find that relatedness both motivated and inhibited teens to reach beyond immediate networks into *extended networks* for informal learning activities.

Author Keywords

Teens; social networks; ties; informal learning; social media; motivation; relatedness; mixed methods.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): miscellaneous

General Terms

Human Factors

INTRODUCTION

Livy joined a community of vegan bloggers and one of fan video creators on YouTube. Through these communities, she made new friends and learned new skills: "*I use [the Internet] to learn different things and get involved in communities…"*.

Shel, on the other hand, chose how to spend time based on her friends, to the point of missing out on developing other interests: *"I kinda want to do gymnastics, but they don't have that in school. So I feel I'm missing out… I could join a gymnastics team, but I just don't like doing things where I don't know anybody..."*

Livy and Shel both consider themselves to be advanced users of the Internet, and both rated themselves similarly on a series of technology skills. However, Livy expands her learning domains by connecting via technologies with her *extended networks*—people outside the networks of the family, friends, and school with whom the average teenager regularly interacts throughout the day. In contrast, Shel limits her learning activities based on what her friends do, thus restricting her connections within her *immediate networks*—people embedded in the average teenager's structured daily activities: school, family, and friends. This paper is primarily about these differences in teens' social and socio-technical behavior of *informal learning* in extracurricular activities. From their experiences, we draw some conceptual design implications aimed at encouraging teens to use technologies to interact with their extended networks for new informal learning opportunities. We use *technologies* to refer to interconnected, computerized tools such as social media, peer-production sites, and texting.

Reaching *extended networks* is important because learning new information is more likely to occur via *weak* and/or *new ties* [16]—people not deeply embedded in existing networks of social relationships. Those that reach extended networks will likely bridge networks that are otherwise disconnected. By spanning such structural holes [9] between networks, these people have "early access" to learn alternative ways of thinking, "which gives them a competitive advantage in seeing good ideas" [9].

Learning via *technologies* has individual and societal benefits. Individually, technologies help teens more easily reach out to their extended networks to access resources not available face-to-face. At the societal level, if people can conveniently reach extended networks, then they have the opportunity to contribute to social capital by acting as brokers between networks; e.g., transferring best practices, or synergizing elements beneficial across networks [9]. Thus, those who reach extended networks can contribute to learning, creativity and innovation in society [9, 11].

Teens are particularly poised to benefit from technologies that support learning from extended networks. Develop-

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mentally, teens are forming vocational interests and life-long learning patterns. These are shaped by teens' socio-cultural ecologies [28]. During the teenage period, these ecologies evolve to depend less on parents or peers [28]. Nowadays, embedded in teens' ecologies are technologies like Facebook, texting, and YouTube as teens are amongst their most frequent users [24]. So, through these technologies we have a design opportunity to support teens' development in ways that broaden their horizons with diversity, specialized knowledge, and social support.

Despite high levels of teen social media use [24] and the benefits of new knowledge via extended networks, we found in this study of teens (ages 13-17) that few interact with extended networks for informal learning. Therefore, our primary research question in this paper is: **why are some teens using technologies for informal learning via extended networks online while others are not**?

In the rest of the paper, we explore first the informal learning activities teens engage in; what contributes to their initiation and continuation; the role of technologies for informal learning, and the differences of technology use with immediate vs. extended networks. We identify design opportunities based on these differences, and delve into participants' social behavior to inform such space. We analyze how technology affordances may explain differences in use. Then, we propose pathways to reaching extended networks. First, we examine how digital skills, technology access, and motivational forces are related to informal learning behaviors. Then, we explore how *relatedness* (desire for belonging and connection) encourages and inhibits technology use with extended networks. Finally, we offer conceptual design recommendations to encourage teens to use their extended networks online for new learning opportunities.

BACKGROUND AND RELATED LITERATURE

Because we are interested in teens' development of sustainable life-long learning behaviors, we focus on the *informal learning* practices occurring in activities that are not required by the school. The social and learning processes occurring in such extracurricular activities are referred to as *informal learning behavior* [1, 4]. Focusing on informal learning is important because more than 80% of teens' waking hours consist of informal learning outside the classroom [1]. More importantly, when teens pursue extracurricular activities of interest such as playing sports in a team, music apprenticeships, or producing and sharing videos with friends, they are more likely to build the social and personal supports needed to sustain their participation in these activities and to develop their formation as persons [4]. That is, in addition to developing expertise, these activity contexts support the development of feelings of competence and sense of belonging [4], which are central to a learner's motivation and well-being [32].

In line with informal learning practices, we take a broad perspective of *learning* as the practices and social interactions that support the development of interests and continued engagement in an activity. Rather than measuring changes in domain expertise or knowledge, we focus on occurrences that support the initiation and continuation in extracurricular learning activities.

Teens spend more time using technologies out of school than in school [2], which sets informal learning as a rich setting to study technology use. In the HCI/CSCW community and nationally, there has been widespread interest in computer-supported learning of technology development skills. Different approaches have been used to advance such learning, including improving the user interface to help learn programming logic [26, 27], learning through gamification [21, 26], tailoring learning to particular interests [8], or addressing social-psychological concerns like sense of community [7] and work attribution [27].

We deliberately chose to focus on teens' informal learning in *any* extracurricular activity rather than specifically on computer programming to prevent biasing against the technologically disadvantaged. To clarify, a digital divide exists, such that the economically disadvantaged cannot afford the resources to regularly access the technology, people, and specialized knowledge needed to succeed at technology development [33]. Furthermore, focusing on technology development can turn off learners who do not identify as computer people. Their social identification constrains their desire to learn about computers [10, 25].

The emerging prominence of social media across people with varying computer skills may provide new informal learning opportunities. This is especially of interest since, according to social constructivism [34], learning occurs through social interaction and the collaborative creation of shared meaning. For example, Bruckman[1] [7] shows that social interaction with community members is the basis for socio-technical support for children learning computer programming. Greenhow and Robelia [17] find that students receive social and academic support from friends through social network sites. Others study the socialization and feedback enabled by peer-content-production-and sharing [6, 27], conduct experiments to assess how virtual environments transform social interactions between teachers and learners [3], or develop social software to support formal learning [14]. Our research differs from this body of work as we focus on how interests develop and are sustained in informal learning contexts, and how technologies may support this.

Another related body of work focuses on social media for friendships, intimate relationships, and social capital. For example, research on digital youth [6, 19, 30] finds that teens largely interact with friends and rarely meet strangers online (which we add, exist in their extended networks) because it is risky and scary [6, 30]. We similarly explore teens' interactions with friends and strangers; however, we

[1] Technically, her stance is social *constructionism*, with an additional focus on object construction; though in both stances knowledge is built by the learner via interaction with an "other".

focus on pathways that facilitate reaching extended networks in areas of interest to enrich informal learning.

Immediate and extended networks

We carefully chose the terms *immediate networks* and *extended networks* after evaluating existing theories. No terminology fully fit our data, but Granovetter's seminal work on *strong* and *weak* ties [16] was most relevant.

Although Granovetter [16]'s work is popularly known, the terms *strong* and *weak* ties naturally lead people to think of the strength of ties at the expense of potentially overlooking two network *structural* characteristics, which he emphasizes: *network density* and the *bridging power* of weak ties. As he states: "one's weak ties which are not local bridges might as well be counted with the strong ties, to maximize separation of the dense from the less dense network sectors" [16]. (Local bridges are ties that directly connect people from socially distant networks [16].) Citing Epstein [13]'s "effective network," Granovetter explains that people in these dense networks are more likely to know each other, and thus more likely to diffuse redundant information that could be obtained from someone else in the network. In contrast, Epstein's "extended network" refers to the remainder of one's network—the non-densely connected and therefore less likely to know each other [13].

We preserved Epstein [13]'s use of *extended networks* rather than "weak ties" (in its structural sense) to refer to people not densely connected with one's network, who can bridge one to new connections regardless of tie strength. Although we do not measure tie strength or network density, conceptually, separating structural concepts from tie strength prevents us from the ambiguous placement of close-ties-that-bridge (and weak-ties-that-do-not-bridge). In other words, there may be people with whom a teen feels close, who *bridge* the teen to extended networks; e.g., a close friend who does not participate in the same activities and who has a distinct set of friends from the teen's. Under a *structural* view that forgoes tie-strength, these close-connections-that-bridge would be considered "weak ties" in extended networks because their networks are not densely connected with the teen's (the reason their ties do not overlap). In fact, "sparse" and "dense" ties rather than "weak" and "strong" ties would better capture density-structure independently from tie strength. Additionally, during Internet times, *extended networks* may include strangers (which could become ties); e.g., new social interactions on deviant art or YouTube.

Conversely, we use the term *immediate networks* to refer to *dense*-connections-of-strong-ties[2] and some weak-ties-that-do-not-bridge; e.g., classmates involved in similar activities. Furthermore, although *immediate networks* share structural meanings with "strong ties" or Epstein's "effective networks" by referring to *densely* connected people with whom teens interact intensely and regularly (i.e., teens' family and activity friends), our findings suggest that these networks are not always "effective." They may act as barriers for learners to reach new networks.

We clarify that both the person who reaches the extended network and the person in the extended network being reached may become local bridges [16] for their immediate networks. The bridge is formed by the link between them. Thus, as made evident in Burt [9], the bridging power of Granovetter [16]'s weak ties is explicitly related to the "vision advantage" in Burt [9]'s work on structural holes. Specifically, people who reach extended networks are positioned to synthesize ideas from otherwise disconnected networks or seemingly distinct ways of thinking; and thus are positioned to learn and generate new ideas.

MIXED METHODS STUDY

We performed a mixed methods study with 23 in-depth semi-structured interviews (120 minutes each) with teens aged 13 to 17. Given the interdisciplinary nature of the problem space, we adopted a mixed-method approach in which "the researcher mixes or combines quantitative and qualitative research techniques, methods…, or language into a single study" [22]. Our purpose is to answer our research questions through triangulation (corroborating results from quantitative and qualitative analysis) and complementarity (use qualitative data to clarify numeric findings) [22] where possible. We drew on literature to inform our data collection instrument and sensitize our analysis, but let the exploratory nature of studying teens' informal learning carry us to unexpected territories. For example, although we were initially vested in teens' learning communities on and offline, our conceptualization of immediate and extended networks arose as each interviewee led us to further probe on why only a few teens interacted with extended networks via technologies.

Our semi-structured interviews guided the direction of the interview, but let participants shape the flow of conversation based on their experiences [31]. The interview had various subsections, as described next.

Informal learning activities: We asked each participant to pick an extracurricular activity for which they "learned something *new*, were creative, and found enjoyment." We asked them to pick an activity that they could "delve into quite deeply", and left this open-ended to explore opportunities to engage teens around their interests. Participants also talked about activities they would have liked to learn but gave up.

Technology use: At the start of the interview, we asked participants about their technology usage and technology skills. After discussing their extracurricular activity, we asked: "What resources if any did you use during…?" their activity, including technologies, information, or people. Participants showed how they used these resources. When possible, they re-enacted what they had done in real-life.

Motivation: As motivation can play an important role in learning [32], we probed for motivational forces behind

[2] We emphasize the term dense rather than strong for network density enables us to know our strong ties' ties.

teens' activities. We drew on Self-Determined Theory (SDT) [32], a theory of motivation. Based on SDT, motivation has two broad categories: intrinsic and extrinsic. *Intrinsic motivation* is the inherent disposition a learner has towards activities for their enjoyment, satisfaction, novelty, and optimal challenge [32]. *Extrinsic motivation* refers to a learner's disposition towards activities which are done to fulfill expectations or achieve separable outcomes [32]. Extrinsic motivation can be internalized, and the degree of internalization falls along a continuum[3] [32].

Questions to get at motivation include: "how did you first get involved in…?" "Who or what inspired you to get involved?" In addition, we asked True/False questions adapted from [32]. Indicators of intrinsic motivation include: "is enjoyable; is interesting to explore; is positively challenging." Indicators of extrinsic motivation include: "because when completed someone will give you a price, reward, or other form of recognizing your accomplishment; to avoid feelings of guilt; to prove to others you can do it."

Relatedness: *Relatedness* refers to the need for belonging and connectedness. Skills, competence or autonomy on their own are insufficient to sustain a learner's engagement [32]. Motivation can become internalized when *relatedness,* autonomy and competence are supported over time.

Relatedness affects initial engagement because people "are prompted by others to whom they feel (or want to feel) attached or related" [32]. Thus, to get at *initial* influence, we derived from motivation questions such as "who inspired you". To get at the support for *continued* engagement, we asked: "Did you get any feedback on how you did in…? From whom? How?" "Did you feel like others valued your learning/participation in this activity?"

Digital and social digital skills, and technology access: As there is widespread interest in the role of digital skills or competencies in enabling life-long learning [18, 33], we sought to examine the relationship between digital skills, technology access, and using technologies with extended networks. We use the terms skills and competencies interchangeably. Because we were particularly interested in how teens initially reached extended networks, we separated the social skills for using communication technologies from other digital skills.

Thus *social digital skills* refer to the sense of competence towards communication and social media technologies. These skills include using email, social network sites, Twitter, creating/using group-tools like Facebook groups and forums, sharing information, and setting privacy (adapted from [18, 33]). *Digital skills* refer to the self-reported sense of competence on technologies that do not involve social interactions with others. Digital skills include using the web, producing websites, searching, altering photos, creating PDFs, audio and video production, and online security related items [18]. Participants self-rated their expertise on a scale (1 = novice, 5 = expert). Items were averaged to represent their overall skills score.

Technology access is also relevant to our study because it is associated with the strategic use of technologies [33]. Though *technology access* is a compound concept [12, 33], we adopted *usage access* or Internet use in hours per week, as a quick proxy during recruitment. Both when screening for participation and during the interviews participants provided basic demographic, technology access, digital, and social digital skills in a brief questionnaire.

PARTICIPANTS

We recruited participants of diverse ethnicity, socio-economic status, and varying levels of technology use. We balanced for gender and levels of Internet access.

We used 12 hours a week or less to categorize a participant as having low technology access. This cutoff point was based on the natural gap between frequent and infrequent Internet users. It was challenging to find participants at low and very high extremes of Internet use. Therefore we used diverse forms of recruiting on and offline. 15/23 participants responded to recruitment via outreach to youth groups, Craig's List, and Facebook. The remaining 8 were recruited from an internal database of people interested in participating in research who joined through a web form.

A total of 23 participants completed our interviews; 52% female, 48% male. 16 of our participants were Caucasian, 3 Asian, 2 Hispanic, and 2 African American. 9 had low technology access *(M = 6.4 hrs/week)*, and 14 had high technology access, *(M = 20 hrs/week)*. In terms of social technologies, those with low access reported spending 2.3 hours a week on Facebook, 6.7 texting, and 1.0 emailing. Those with high access reported spending 9.2 hours a week on Facebook, 18.9 texting, and 2.8 emailing. While some participants had lower levels of access in terms of hours spent online, 22/23 participants had access to the Internet at home. One used it via the library. In terms of self-reported Internet use experience, 9% were beginners, 48% intermediate, 35% advanced, and 9 % expert.

ANALYSIS

All interviews were transcribed. For open-ended questions, we used the constant comparative method, balancing systematic qualitative data coding with the constant reintegration of theoretical notions arising from new data [15]. In line with the notion of *sensitizing* concepts [5], when insights emerged from a participant's interview data, we iteratively reviewed previous interviews to examine whether the newly realized concept existed in previous participants, and/or how previous participants' experiences changed our initial interpretation of newly emerged concepts. We synthesized our qualitative coding with the close-ended survey questions, and found no contradictions. Through this process, we identified conceptual categories that co-occurred across participants, and evaluated the role of technologies in their activities and pathways to reaching extended networks. Two researchers independently rated

[3] This continuum includes 5 levels, which we used to rate teens' motivation. For simplicity, we only describe the extremes, and *extrinsic* is a composite of the two most external levels.

participants on their extent of a) technology use (see Levels of Mediated Sociality section) to reach people and information in extended networks (or Tech with Extended Networks) and b) internalized motivation for each activity. Large discrepancies between raters were discussed. Then, participants were re-rated, and these ratings averaged.

A VARIETY OF LEARNING ACTIVITIES

23 participants nominated 55 extracurricular activities ($M = 2.4$) for which they felt they were learning something new, being creative, and found enjoyment. Table 1 summarizes 47 activities which were discussed in-depth during the interviews, excluding activities that participants had given up. For short, we refer to these as *preferred learning activities*. These activities covered a wide range of topics.

Type of Activity	Name of Learning Activity		Num. Activities	Num. using Tech.
Team/crew sports	Track (3)* Baseball (3)* Swimming (2)* Martial arts (2)* Basketball (1)*	Football (1) Volleyball (1) Skiing (1) Breakdancing (1)*	15	6
Music	Piano (3)* Guitar (2)** Choir (1)	Violin (1) Clarinet (1)	8	3
Making/ building	Minecraft (2)** Building computers (1)* Carving (1)	Making things (1)* Faceplate painting (1)*	6	5
Video production	YouTube video production (4)**** General video production (1)*		5	5
Service/ personal development	Boy scout (1)* Girl scout (1) Business week (1) Foreign languages (1) Hanging out with friends (1)		5	1
Other content production	Blogging (1)* Poetry writing (1)* Story writing (1)		3	2
Cooking/ baking	Baking (2)** Cooking (1)		3	2
Art	Photography (1)* Painting (1)		2	1
Total			**47**	**25**

Table 1. Preferred learning activities. *Number of asterisks = number of teens who used technologies for the activity. A teen may be counted twice if s/he discussed more than one activity in depth.

Participants showed remarkable diversity in extracurricular areas of interest. Surprisingly, 32% of the preferred learning activities were team or group sports. Of the non-team activities, 17% were music; 13% were of the making/building type; and 10% were video production and service development each. The rest were on writing, cooking, and art/photography.

RELATEDNESS FOR INITIATION AND CONTINUATION

We examine how teens initiate and continue engaging in *any* new informal learning activities, whether technologically-mediated or not, to later draw implications for encouraging teens to initiate and continue reaching extended networks. We found that across all participants, *sense of relatedness*, or feelings of belonging and connection was key to their engagement. The majority of teens initiated new learning activities when prompted by people with whom teens felt a sense of *relatedness* (supporting self-determination theory [32]). For example, teens were most frequently prompted by friends (12 activities), moms (11), and dads (8). Group/teams only influenced the initial engagement of 2 activities. Yet, group/teams were the reason for continued engagement for 10 activities. For example, Kay started swimming to spend time with one friend (extrinsic motivation not influenced by group/team). Yet, her identification with the swim team influenced her decision to continue with swimming rather than soccer:

> "I chose swimming... Soccer is a lot of drama, and I could relate better to my swim mates… Swim team people are studious, not slackers. Soccer people are more like party, don't give a whatever people… I identified more with swim people" *(Kay[4])*.

Group identity affected both genders, and lack of group identity was usually followed by giving the activity up:

> "I wasn't socially included in my team though my coach liked me. That's how I decided to leave" *(Livy)*.

Of the 47 learning activities for which there was sufficient data to code on motivation, 42 (89%) were initiated by a desire for connection with close ones. In addition, many who had ongoing, continued engagement in the learning activity did not rely solely on intrinsic motivation. Rather in 35 (74%) activities, teens mentioned someone to whom they felt attached or related who supported the teens' continuation (see Table 2).

Type of Motivation at Interview	N	Percent (of Row) Prompted by Others to Initiate Activity	Percent (of Row) Relying on Others to Continue Activity
Extrinsic *only*	18	17 (94%)	16 (89%)
Intrinsic *only*	7	5 (71%)	3 (43%)
All activities	47	42 (89%)	35 (74%)

Table 2. Role of *relatedness* in initiating and sustaining engagement in activities by type of motivation. For simplicity, intermediate levels of motivation are not represented, but their values lie between the extrinsic and intrinsic values.

Table 2 shows encouraging data in light of current theory. To elaborate, according to [32], intrinsically motivated activities are more likely to be sustained over time. And, the internalization of motivation is more likely to occur when *relatedness* is supported. However, aiming for motivation internalization would be a challenging and uncertain task for a technologist. Our findings suggest that technology designers can contribute to initial and continued engagement in new learning activities by designing for increased sense of relatedness. As Table 2 shows, continued engagement in new activities is possible even when motiva-

[4] We use pseudonyms when quoting participants.

tion is not internalized: Although a higher percentage of extrinsically motivated activities relied on others to be initiated (94% vs. 71% of intrinsically motivated activities) a high percentage of these extrinsically motivated activities also relied on others to be continued (89%).

Given its importance, in later findings, we will continue to weigh the role of sense of relatedness in teens' engagement in informal learning activities.

ROLE OF TECHNOLOGY IN INFORMAL LEARNING

As there is value in reaching extended networks for learning, and technologies play a key role in reaching extended networks, we examine technology's role in teens' activities. 25/47 activities incorporated technologies; 100% of video production, 83% of making/building, 67% each of other content production and cooking/baking. Only 40% of sports and 20% of service/development activities included technology use, **suggesting areas for potential growth in use.** A counter argument to such potential growth is that some activities may be more suited to technology use than others. However, our data shows that across all activities, social support played a strong role in using technologies with extended networks, especially considering the high use of YouTube in sports—an activity some may assess to be less suited for technology use.

Online Resources as Learning Supplements

The role of technologies in teens' activities was varied. From the activities in Table 1, the most common purpose for which participants used technologies was to supplement face-to-face learning with people in immediate networks. 14 activities fit this purpose. That is, participants reported that their main learning source was a coach or regular practice. In such cases, YouTube was the most frequently used technology to consult experts and/or role models' performing the learning activity. For example:

> "I've spent a lot of time on YouTube watching people from the Olympics swim. Two days ago I watched a technique for kicking…and just kept that in my mind… In the pool, I just play that image in my head again and try to do that in the water" *(Kay).*

Comments on videos were also consulted for learning:

> "If I don't know a move, I look through a comment on YouTube to see if anybody comments about that move. If they do, I just look it up to see if that's what it's called. Then I find a 'how to' video …" *(Quen).*

Not surprisingly, search engines were used by most teens to find information. Surprisingly, YouTube was used by some as the first search location:

> "I usually search on YouTube first. If I can't find it there, then I try Google" *(Dan).*

The general web and wiki's were less frequently mentioned as supplements to other types of learning.

Online as Main Learning Resource

For at least seven of the activities mentioned, technologies were the main source for learning. Here, activities that stood out involved searching for information as a step prior to performing the activity (e.g., baking, or how to modify a computer game). For these activities, participants tended to use the web or subject-specific wikis. One exception was Cat, who was learning piano primarily from YouTube:

> "I learn 80% from YouTube and 20% from my sister… I'm a slow learner… [With YouTube] I can replay over and over without having to ask [my sister] to repeat and frustrate [her]…" *(Cat).*

YouTube stood out for its approachability, its repeated access to lively, albeit not "live" role-models, and affording a sense of independence and social appropriateness.

Inspiring Creative Efforts in Informal Learning Activities

A few of the preferred learning activities were artistic: photography, poetry, and drawing. Participants primarily used the web to find inspiration; e.g., looking up images, synonyms, or samples to consult for their creation. Sites used include Poetry.com, Deviant Art, Lookbook.nu, and YouTube, as inspiration for video production.

Push Information and Participate in Communities

A few participants used technologies to push personal creations/productions to a wider community of people. Jan uses Tagged.com specifically to post poems and reach people who are not connected to her immediate networks. Her extended networks in Tagged.com enabled her to experiment freely with new expressions about her feelings and not risk judgment from her immediate networks:

> "What have I posted on here? More about how I'm actually feeling… I've got my parents on Facebook. So when there's something I wanna express but I don't want my parents to see it 'cause they'll freak out or something, then I'll put it on here" *(Jan).*

Livy uses it to spread her writing widely and participate in the blogging community:

> "With blogging, I know that I can reach a wider audience sooner than other people... I write openly and simply… so I don't intimidate people, and can reach friends and others in the blogging network" *(Livy).*

The use of blogs to reach others with similar abilities or interests and the popular use of YouTube to supplement face-to-face learning (albeit primarily for physical and step-by-step activities) raises the question: were some technologies used more frequently to reach extended networks than others? We address this in the next section.

LEVELS OF MEDIATED SOCIALITY: 4-TIER ANALYSIS

Given the possibility that some technologies facilitate reaching extended networks more than others, we delve deeper into the type of interaction with extended networks across learning activities. Presumably, direct and two-way social interaction is likely to provide different learning opportunities than one-way consumption of information. Therefore, we examined technology use in terms of level of interpersonal sociality with the source. Tier 1: No interpersonal sociality. Participant consumed information without regard for its authorship or potential interaction. Tier 2: Participant obtained information from an identified author

with whom they illustrated socio-emotional connection, but did not interact. Tier 3: Participant pushed content as identified author, and exhibited socio-emotional connection from others' feedback. Tier 4: Two-way interaction. Social interaction is more involved at higher Tier Levels[5].

Tier 1: Get Info. (No Sociality)	**Tier 2:** Get Info. From People	**Tier 3:** Push Info. To People	**Tier 4:** 2-Way Interaction
	a. Technologies Used With *EXTENDED* Networks		
Web –17 Specific site –3 Wikis –2 Q&A sites –2 Minecraft lab –1	YouTube –13 Specific site –1 Twitter –1	Blogs –2 YouTube –2 Tagged.com –1	Blog –2 Twitter –1 FB Group –1 Tagged.com –1 Email –1
Total: 25 tech mentions	**Total: 15** tech mentions	**Total: 5** tech mentions	**Total: 7** tech mentions
20 activities, 20 participants	13 activities, 13 participants	5 activities, 5 participants	6 activities, 6 participants
	b. Technologies Used With *IMMEDIATE* Networks		
NA	FB –1	FB –1 Blog –1	FB$^{\Psi}$ –13 FB Group* –7 Texting –8 Blog –3 XBox –2 IM –2 Twitter –1 Email –1
Total: 0 tech mentions	**Total: 1** tech mentions	**Total: 2** tech mentions	**Total: 37** tech mentions
0 activities, 0 participants	1 activity, 1 participant	1 activity, 1 participant	30 activities, 22 participants

$^{\Psi}$Includes FB private chat. *Includes the use of FB group chat.

Table 3. Technologies used with a) *extended* and b) *immediate networks*: 4-Tier analysis. Tier 1: no social or emotional connection. Tiers 2 and 3: no 2-way interaction, but involve socio-emotional connection. Number next to technology: number of participants using it for a learning activity. Info = information; FB = Facebook; IM = instant messaging.

On Table 3, we categorize participants' technology use with extended (3a) vs. immediate networks (3b). Based on our definition of extended networks as people outside the bounds of one's immediate networks, it would seem strange that watching a YouTube video is categorized as "people" (in Tiers 2 and 3). We clarify that although there is no direct social interaction in Tiers 2 or 3, in these Tiers, participants exhibited socio-emotional connection with others, such as affection, inspiration, and desire to emulate. Thus, Tiers 2 and 3 are of higher sociality than Tier 1, which does not involve any social or emotional connection. Despite not being part of participants' interpersonal networks, we placed Tier 1 alongside Tables 3a and 3b for easy comparison. We placed accessing web information next to Table 3a because such web sources reside outside our teens' immediate networks.

[5] We assume producing and sharing content as an identifiable author is a more involved process than obtaining content.

Most participants accessed information from the web. However, as the social interaction became more involved (higher Tier) the number of participants who reached extended networks via technologies drastically diminished. 20 participants used the web or other virtual worlds for information, without involving any social interaction (Tier 1). 13 used YouTube, Twitter, and content specific sites to get information from known individuals or role models (Tier 2). 5 used content production sites to push information to people (Tier 3), and only 6 used various technologies for 2-way social interaction with people in extended networks (Tier 4).

Many[6] participants used networked technologies for 2-way social interaction, but primarily with their *immediate networks* (Table 3b). As can be seen, with immediate networks, 30 activities involve 2-way social interaction (compared to 6 in Table 3a). Table 3 also shows that some technologies were used mainly for 2-way social interaction with immediate networks (e.g., Facebook, texting), while others were used mainly to learn from role models (e.g., one-way consumption on YouTube). We see the gaps in quantity and type of technologies used with immediate and extended networks, presented above, as **design opportunities for the CSCW community to support informal learning via extended networks** (Figure 1).

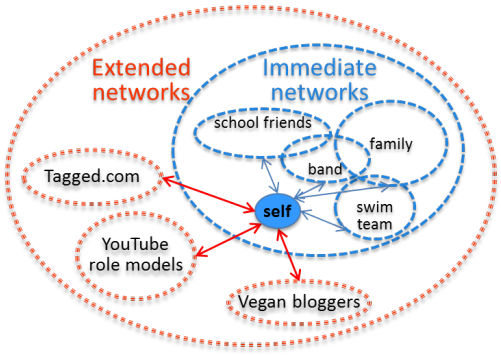

Figure 1. Illustration of informal learning opportunities via extended networks and related design opportunities.

Lines = social connections. Red solid lines = design opportunities for interaction with extended networks; e.g., experts on YouTube, global Vegan Bloggers, or strangers on Tagged.com

Social media arguably enhance people's relatedness, yet they seldom help teens build learning relationships with *extended networks* the way Livy did on blogs. Synthesizing the identified design opportunities with findings on relatedness, we see room to **design for *sense of relatedness* with teen-learners' *extended networks.***

To inform such space, we further delve into participants' social behavior: how they used technologies with immediate and extended networks based on their affordances; and pathways to reaching extended networks.

[6] Likely, more teens used technologies in their activities. We report what teens voluntarily shared, which has validity because people tend to report relatively stable patterns of interaction [35].

USES BASED ON SOCIALITY AFFORDED

In this section we discuss differences in technology use with immediate vs. extended networks. We draw on technology affordances to explain such differences. We loosely adopt Norman [29]'s conceptualization of *affordance* as action possibilities that a technology offers and the user is able to perceive and enact. We posit that different technologies afford different *sociality* or relational qualities of interaction. Not all relational qualities may create a path to extended networks; yet, they provide insights for the gaps between uses with immediate and extended networks.

As mentioned, YouTube stood out as one of the most used technologies to reach extended networks. Interestingly, YouTube use with extended networks was mostly for one-way consumption, while Facebook and texting were used for two-way interaction with immediate networks. We found that the main difference existed due to the concern, care, and social validation that teens tend to seek *privately* from "insiders" in their immediate networks with a common history to the teens. For example, before every swimming practice, Jill and her swim-friends texted each other to send reminders or find out why someone is missing; e.g., "it's your event, where are you?" Kay used Facebook's live chat to get last minute advice from seniors in the swim team. Jan who posted her art publically in tagged.com emailed drafts of her poems to a group of close friends for feedback.

Thus we ask, while peer-production sites like YouTube support learning from role models, could they also provide social support in informal learning the way texting and Facebook's chat do? We found value in considering the power that teens' ability to affect others had on their level of engagement in informal learning activities.

In both technology-mediated and non-mediated activities, providing for others made teens feel worthy and encouraged them to sustain involvement in the new activity while providing social support to others. For example, as a mentor to new freshmen, Meg felt central to her school community. Eventually, she gave freshmen her cell phone number to be available as needed. Livy felt that through her blog, she was useful to other vegans in need of it (e.g., sharing vegan recipes and "things other [vegans] might not have access to"). As mentioned, she became avidly involved in the vegan blogging community, friending bloggers in person. Thus, we see opportunities **to design for continued engagement in new informal learning by supporting teens' contribution to the needs of others** in extended networks.

Furthermore, as contributing to the needs of others in extended networks may evolve into more personal interactions, and given the few teens who had personal interactions on peer-production sites, we also see opportunities to design **for more intimate relationships with extended networks in peer-production sites.**

PATHWAYS TO EXTENDED NETWORKS

Personal Factors: Digital Skills, Access, Motivation

We first evaluate simple associations (correlations): how personal factors like Digital Skills, Technology Access, Internalized Motivation, and Relatedness are associated with using technologies to reach extended networks for informal learning or Tech with Extended Networks. Our participants had intermediate levels of Digital Skills (M = 3.0, sd = .65, where 1 = novice and 5 = expert) and higher levels of Social Digital Skills (M = 3.5, sd = *.68*). Participants' Technology Access (Internet use) was also high (M = *14.97 hrs/week, sd = 8.5*). However, we found overall intermediate levels of using Tech with Extended Networks (M = *4.97, sd = 2.6,* where 1 = did not use at all, 10 = used frequently and intensely). In terms of motivation, participants had intermediate levels of internalized motivation (M = *4.7, sd = 1.57*, where 1 = extrinsic and 7 = intrinsic), and sense of relatedness played a role in a high proportion of participants' involvement in informal learning activities (M =.75, where 0 = absent, and 1 = present).

	Digital Skills	Social Digital Skills	Internalized Motivation	Relatedness	Tech with Extended Networks
Tech Access	.31	.26	.24	.18	**.48**
Digital Skills		**.70**	.38	.17	**.46**
Social Digital Skills			.29	.06	.26
Internalized Motivation				-.18	.28
Relatedness					.31

Table 4. Correlations (Pearson) between concepts of interests. Bolded items are significant at $p < .05$ (2-tailed).

Not surprisingly, Digital Skills and Technology Access are significantly correlated with Tech with Extended Networks (r = .46, p <.05 and r = *.48, p < .05 respectively*). In other words, teens with higher Digital Skills scores were more likely than not to use Tech with Extended Networks; and teens who spent more time online were more likely than not to use Tech with Extended Networks (Table 4).

However, correlations did not fully capture the relationship between concepts of interest. For example, Relatedness also played a critical role in using Tech with Extended Networks, as suggested earlier. Yet, the correlation was not significant because Relatedness both encouraged and inhibited teens' use of Tech with Extended Networks (as described later). We also found that Internalized Motivation was not significantly correlated with Tech with Extended Networks because as reported, participants go online to learn because of Relatedness—they are prompted by others or seek out a sense of connection with others, not because they had an intrinsic desire to learn about the topic.

Table 4 also does not capture the ceiling effect in Social Digital Skills—that is, because these skills consisted of

using communication and social media technologies, which most participants used frequently and were good at, a correlation with Tech with Extended Networks could not be observed. In comparison, Digital Skills included sophisticated technology skills on which participants tended to rate low, such as addressing computer malware, configuring a server, and building websites. Knowing these skills usually meant that the participant accessed non-regular school resources. We recognize that there may be more levels of sophistication to Social Digital Skills, and raise this as an area for future researchers to further address.

In short, we must consider the importance of basic Technology Access, Digital Skills, and Relatedness when designing for teens to reach extended networks.

Social Factors: Reaching Extended Networks or Not

For the most part, the social factors contributing to reaching extended networks pertain to relatedness—teens' desire for social validation and connection, as described below.

Pushed by Immediate Network

Despite existing research suggesting that teens mainly use technologies with existing ties [6, 19, 30], we were still surprised by teens' heavy reliance on friends and family for inspiration, information, and social support in informal learning contexts. Often, participants reached extended networks when pushed by someone in their immediate networks with whom they sought connection or social validation. For example, Brad is extrinsically motivated to be in Boy Scouts because he wants to earn his Eagle Scout, the highest rank in the Boy Scouts of America. He was one of the few who used technologies with people in extended networks. He emailed a chemist to evaluate his chemistry merit badge to be awarded the next ranking level. Brad was pushed by his immediate network—scouts—to reach expertise from extended networks.

Similarly, Pat's enjoyment of baseball is centered around friends (extrinsic motivation): "I went to baseball camp… to hang out with my friend." Pat observed baseball role models on YouTube (people in extended networks) at his coach's suggestion (pushed by immediate network).

Being pushed by immediate networks to reach extended resources occurred also for participants engaging in activities of internalized motivation. For instance, Pete who enjoyed video production in itself (internalized motivation) needed a push to try new unfamiliar resources. He had not used interest groups as resources for video production, but:

> "If someone suggested that I find interest groups online, I'd give it a try" *(Pete)*.

Design can raise teens' awareness of friends' technology use with extended networks and reward the emulation of such behavior to *push* teens to reach extended networks.

Pulled by Extended Network

For some teens, encounters and exposure to specific communities of interest in social media (in their extended networks) further *pulled* them to *continue* engaging in completely new activities. For example, Livy shares:

> "I was taking an English class and thought that if I started blogging, I would practice my writing style... Veganism was something new to me… I learned more about it via others' blogs… I [too] started sharing [blogging] good vegan recipes I found" *(Livy)*.

For some teens, regular exposure to content-sharing sites (YouTube, blogs) was followed by learning to create content for these media. Dan is one such example. He created his own YouTube video after watching videos from accounts he admired. From YouTube users he followed, he learned about Indy Mogul, where he learned video production tips for his video. Further feedback on YouTube encouraged him to produce more videos.

In Livy's case sharing content with the vegan community led to interacting with people in these extended networks. As Livy became more centrally embedded in this community, she also volunteered, and won a cooking contest. These interactions sustained her engagement:

> "Amy who runs a big vegan blog shared my blog. I didn't blog to get followers, but when others repost or follow, it feels good" *(Livy)*.

As "reposts" were not triggers for teens' initial engagement with extended networks, there is room for design to increase the pull by extended networks by matching teens with similar interests across networks.

Lack of Support in Immediate Networks

Reaching extended networks may also occur due to lack of support from people in teens' immediate networks. For example, after learning video production from his cousin, Pete got interested in taking a video class at school. Then, one day, he faced the need to use a video resource online community because he exhausted his teacher's knowledge:

> "I wanted to do more things that my teacher didn't really know… He suggested I search online. So, I went online to search … I learned how to make exploding text using a tutorial on *Video Copilot*" *(Pete)*.

To add to the value of reaching extended networks, as a byproduct of needing to reach his extended networks, Pete mastered other digital skills: He admits to searching online more often now that he "can find stuff more easily."

We note that the "lack of support" in immediate networks may be informational, social, and/or emotional. For instance, we introduced Jan earlier, who used Tagged.com to connect with people that would not judge her creative expressions. For Cat, impatience from her sister/piano teacher led her to reach pianists on YouTube to learn piano.

While we expected to find that learners with internalized motivation were more likely to reach extended networks than not, neither our correlational nor qualitative data supported this expectation. For instance, while Pete had internalized motivation for video production and Cat had extrinsic motivation for piano (she wanted to play because her friends played at social gatherings), they both reached their extended networks due to lack of support from their

immediate networks. In Pete's case, his teacher did not have the knowledge. In Cat's case, she did not have the social support from her sister. Thus, even without intrinsic motivation, if a learner's immediate networks cannot fulfill the teens' need, then s/he might reach extended networks.

While it would be unethical to purposefully make a teens' immediate network unavailable for support, design can heighten a teens' awareness about the additional and easily reachable expertise in extended networks.

Immediate Networks as Barriers

In previous sections, immediate networks were the triggers for some teens to reach extended networks. However, immediate networks also acted as barriers for some teens to reach into extended networks to support their informal learning activities, such as the case of Shel in the introduction. Mar, who used the Internet less than 3 hours a week, was also constrained by her immediate network:

> "Mom's paranoid tendencies about viruses have rubbed off on me… I tend to be on the computer fairly conservatively… that's how I avoid viruses…" *(Mar).*

While some teens may be reaching extended networks for pragmatic reasons (e.g., whether they can get the support they need in their immediate networks or not), our data suggests strongly that relatedness plays a key role in teens' initiation and engagement in informal learning activities. Additionally, if prompted, teens may try out reaching into extended networks. Furthermore, parents' attitudes matter. Thus, incorporating parents' concerns when designing to encourage reaching into extended networks for informal learning is a feasible (and worthwhile) challenge.

IMPLICATIONS & RECOMMENDATIONS

Based on teens' informal learning, we identified design spaces for engagement with extended networks. We provide conceptual design recommendations in such spaces.

1. Support relatedness: Enable the *pull by extended networks* by helping teens develop friendships with similar others in extended networks. Increase awareness of how friends reach extended networks as friends can *push* teens to do the same, and reward the adoption of these friends' behavior. While current social media do display recommendations for new connections, these are usually not purposefully contextualized within learning activities. Furthermore, support geographic collocation. While not stated earlier, for most teens, regular physical interaction and ease of face-to-face access were important conditions for continuation. Finally, support ways for teens to provide for others' needs because it increases their sense of belonging and consequently, their continued involvement.

2. Support mentoring structure: Make evident the existence of accessible expertise outside teens' immediate networks. Match learners with mentors who have the expertise sought in ways that encourage sustained relationships. One way to support continued engagement is to give learners the opportunity to play mentoring roles, especially since a mentoring structure, which rotates responsibilities, may also contribute to feelings of worth and inclusion.

3. Design private communication channels in peer-production sites: Blend private communication channels in peer production sites with other communication channels. We see opportunities for innovation where elements of social support, validation, mentoring, and private interactions are combined with YouTube affordances (lively video demonstrations, approachability, repeatability, and access to expertise world-wide). Here Isaacs et al. [20]'s channel blending study should also be consulted.

4. Technology as prompt: Embed peer or professionally created digital artifacts of diverse content and materiality in teens' socio-technical environments. Many teens initiated activities through encounters with artifacts, both digitally (e.g., Livy and blogs; Dan and YouTube videos) and in analog formats (a not yet described example is Mel being inspired to learn photography by photo displays at school).

5. Design for the learner's social ecology: This includes family and friends. Teens' immediate networks sometimes acted as barriers to reaching extended networks. As parents are influential in teens' technology and learning attitudes, systems need to support parent's changing roles in teens' development of self-directed learning. For example, provide parental "support" opportunities to let parents feel that the activity is beneficial. Design for parent-child or peers to use the technology *together* in collaboration.

LIMITATIONS

It should be noted that we do not have a representative sample that is generalizable to the population of teens. Our participants were selected for technological and demographic diversity to help carve design spaces. We also do not explicitly state how online safety can be addressed through design. Such focus would require a separate study. Additionally, learning via extended networks may not produce qualitatively better outcomes than learning via immediate networks. Our emphasis is on the opportunities for new learning and the synergy of ideas that are more likely to be offered by reaching extended networks.

CONCLUSIONS & CONTRIBUTIONS

Interacting with people in extended networks yields valuable informal learning opportunities. In a study of teens' informal learning in extracurricular activities, we found that few used technologies to interact with their extended networks. We found sense of relatedness to be such a strong motivator to engage in informal learning activities that sociality should be a primary consideration in designing informal learning systems for teens.

We observed that a higher percentage of teens used technologies with immediate networks vs. extended networks. In examining how teens used technologies with their social relationships, we found that technologies used with extended networks were not as often used for developing deeper interpersonal relationships in the way that technologies used with immediate networks were. By delving deeper into the reasons why teens' reach beyond their immediate

networks we provide conceptual recommendations for how to encourage teens to reach extended networks online for informal learning, such as matching learners with similar interests, mentoring relationships, and co-learning.

We make four valuable contributions:

1. We identified the benefits of extended networks for informal learning, and **defined the term by clarifying structural concepts in Granovetter [16] and Burt [9].**
2. By exploring teens' informal learning in extracurricular contexts, **we uncovered new design opportunities** in the void of teens' interactions with extended networks.
3. We explored **pathways to reaching extended networks**, including the role of digital skills, technology access, and motivation, and most importantly the *desire for relatedness* both pushing and pulling them to new informal learning opportunities via extended networks.
4. We provided **design recommendations** that address relatedness, social inclusion, and inspirational prompts; and fill the gap between different affordances of technologies used with immediate and extended networks.

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