Media Technologies and Learning in the StarCraft eSport Community

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ABSTRACT

Interest-driven Internet communities often use an assemblage of media technologies to support knowledge creation and learning. In this paper, we examine the uneven functions of these media technologies in meeting the learning needs of online game players. StarCraft is an online game and electronic sport where millions around the world compete in virtual battlegrounds. To become better players, gamers actively share strategies in online forums, wiki, videos, and in person. We conducted participant observation of a StarCraft community known as Teamliquid. We performed 24 in-depth interviews with professional gamers, editors, game commentators, and community leaders. We found that the novice learners generally learned from, and participated in, public media channels, whereas the StarCraft experts congregated in small teams in which members learn from each other within private media channels and in person. We use the concepts of *informational media* and *socially-oriented media* to describe the general learning needs supported by media technologies.

Author Keywords

Communities of practice, online community, learning, online games

ACM Classification Keywords

H.5.3.

INTRODUCTION

Many Internet communities are driven by a specific interest, e.g., online gaming or modding. In these interest-driven communities, members use an assemblage of media technologies, e.g., wikis, online forums, chat rooms, video on demand on sites like YouTube, and Internet TV, to support mass collaboration. While previous studies in human-computer interaction have described interest-driven communities, these are mostly communities built on a specific media technology, e.g., Wikipedia [5,18]. Few studies have paid attention to Internet communities that utilize multiple technologies, and interrogate the different functions media technologies play in supporting the communities' activities.

The normalcy of multi-technology use in work settings has been discussed in previous studies [4]; however, few had examined such use in Internet communities. Ito [15] has suggested that Internet communities are networked publics, in which media technologies, which allow community members to interact, are also mass media. Wenger, et al. [39] suggest that community administrators and managers match media technologies to the communities' activities and their social configurations.

StarCraft (1998) is an electronic sport (eSport), organized as a set of leagues that "compete through networked games and related activities" [16]. In the StarCraft community, "metagame" is a term synonymous with strategy, but it also refers to the "planning, preparation, or maneuvering that a player does outside of actual gameplay" [23]. To master the StarCraft metagame, players attend tournaments, participate in league games, and worked with practice partners. On the Internet, players discuss the game on online forums, wiki sites, Internet telephone, and via instant messaging tools. Players often analyze StarCraft matches shown on Internet television.

From October 2011 to April 2012, we performed seven months of participant observation of a StarCraft community known as Teamliquid (Teamliquid.net). Teamliquid's website is the most popular community site for English speaking StarCraft players located in the U.S. and other European countries. We observed player interactions in Teamliquid's online forums and wiki. We participated in one local tournament and two gatherings in local bars. We performed 24 in-depth interviews with StarCraft participants including professional gamers (pro-gamers), amateur gamers, editors, game commentators (casters), and community leaders. All interviews were audio-recorded and transcribed.

In this paper, we discuss how the adoption of media technologies is uneven in the StarCraft community, e.g., some collaborative contexts may favor tools like instant messaging to online forums. We discuss social-technical formations that function alongside media technologies that support learning in Internet communities.

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LEARNING THEORIES

In this research, we adopt the perspective that learning is fundamentally social, and is often supported through peer-to-peer interaction [36,37,40]. Social learning is a well-established area of research, with a history that stretches as far back as the early part of the 20th century. This orientation to the social nature of learning is well established in socialcultural and "situated" theories of learning. For example, Lev Vygotsky's influential work in the 1930s suggested that learning and development happen through social interaction with a more capable person [13,35]. In this sense, our interactions with learning partners—primarily what we say to each other—shapes the way we will subsequently perceive the world [13].

Peer-to-peer and informal learning in online environments, unlike learning through classroom activities, resembles on-the-job learning [9]. Learners organize themselves to resolve new and emerging challenges, thus creating new knowledge in the process of learning [9]. Internet technologies offer immense potential as infrastructure that supports peer-based social learning [27].

Situated learning theory has had an influence in human-computer interaction research primarily through the concept of "communities of practice," which grew out of studies of work practices [20]. The concept was later applied widely to knowledge management practices, as well as various organizational contexts such as Shell and the World Bank.

A community of practice is a social group that shares a set of practices through which they gain expertise and guide new members into the group. Learners in communities of practice take the role of "legitimate peripheral participation" which is an entry point into more central participation or formal membership [37]. Social groups are important to learning because knowledge does not reside solely in individuals and in documents, but is embedded in social practices and interactions. For example, professionals often share stories that contain key lessons for other professionals. The influence of communities of practice frameworks ushered in an era when corporations began to nurture professional groups as incubators of knowledge and learning [38].

Internet communities have been found to exhibit characteristics of communities of practice [5]; however, there are key differences between Internet communities and companies. Members of Internet communities are often volunteers [1]. While companies can mandate the participation of their employees in communities of practice, Internet communities can only motivate member participation out of shared interests.

Not all Internet groups are interest-driven. Some, like eBay are market-driven, and others, like Facebook are centered on socializing rather than on specific interests. While the Wikipedia community is driven by an interest in developing an information resource [5], it has been reported as being supported by a dedicated media technology [5,18]. We have observed that most other interest-driven Internet communities adopt multiple technologies to support their activities and wikis are only some of the many technologies supporting collaborative work. In interest-driven and peer-based Internet communities, "work" often comprises the distribution, production, remixing, and consumption of digital media contents, e.g., text, graphics, videos, and software applications, in a highly-distributed collaborative setting [1].

Prior studies have examined the use of multiple technologies in industrial work settings, e.g., ship navigation [4]. Bodker and Anderson [4] interrogated use of artifacts like papers and control instruments in ships, and suggested the concept of *multi-mediation*. In multi-mediation, artifacts may mediate work all at the same time, in a chain of sequence, or in a distributed manner. In the latter, a ship's management team and engineers are using different tools to support the overarching task of navigating a ship [4].

Similarly, media technologies can connect distributed communities into a complex social-technical system, in which different social groups collaborate to solve common problems [14,39]. Research has documented how technological entrepreneurs alternate between use of social media and in-person events to foster a culture of technological knowledge sharing [6]. And more recent research on communities of practice has begun to explore the role of Internet technologies mediating distributed communities [38,39]. Wenger et al. [38] suggest that corporations pay attention to what could compromise communication among globally distributed team members, such as distance, size, culture, and the intellectual ownership of new ideas [38]. Wenger et al. [39] use the term *digital habitat* to describe a collection of Internet tools, platforms, features, and their configurations which support communities of practice.

An issue of online collaboration is that Internet media limit the transfer of knowledge between distant localities. Nonaka and Nishiguchi [26] coined the term "ba" to refer to knowledge residing within a physical context. As soon as the knowledge is re-represented into a media format, e.g., text, it loses its original depth and richness:

> Knowledge is embedded in ba, where it is then acquired through one's own experience or reflections on the experiences of others. If knowledge is separated from ba, it turns into information, which can then be communicated independently from the ba. Information resides in media and networks, while knowledge resides in ba. [26]

Knowledge written in text becomes information [33]. This view complements activity theory, which describes texts as merely the symbolic representation of what we know [36]. Learning is only effective when learners not only consume information transmitted through media technologies, but also apply the information to real-life practices.

Frameworks that have been developed in the context of communities of practice research can be productively applied and extended to online interest-driven learning environment. Other constructs, such as digital habitat and multi-mediation, are also relevant to the online context. A study of the StarCraft community—being media technology supported, peer-based, openly networked, and less institutionally bounded—can help enrich these theories by demonstrating how particular media technologies are mobilized to support learning.

STARCRAFT: THE GAME

StarCraft is an electronic sport (eSport) game with International tournaments in Asia, Europe, and North America. In 2011, these tournaments had awarded more than $2.5 million in overall prizes [30]. In the current StarCraft scene, two StarCraft versions are most popular among players, Brood War (1999) and StarCraft II (2010). By December 2010, Brood War had sold 9.5 million copies and StarCraft II had sold 4.5 million copies worldwide. StarCraft II is similar to Brood War (BW) except for improved graphics and alterations to combat units. Both BW and StarCraft II players congregate and discuss the games in the same community site, Teamliquid.net. Many of the earliest StarCraft II practices were inherited from BW. Furthermore, many StarCraft II players are also former StarCraft I players. Due to these reasons, we treated both games as residing within the same learning ecology.

A StarCraft match is played on a virtual battleground, a map containing terrains such as mineral patches, cliffs, and ramps. In a StarCraft match, a player wins when he has eliminated his opponent from the map, or when his opponent admits defeat. Each player starts at a different location, where he has a few minutes to build up his army.

A starting location includes a mineral patch containing a limited amount of resources, see Figure 1. Players collect and allocate these resources to make buildings and units. Players have to carefully deliberate the allocation of these limited resources to approximately 15 different types of buildings and 15 types of units that are available. Different unit types can do a combination of different things, e.g., collect resources, fly over terrains, or fight in combat. The units a player can make depend on buildings she had already constructed. Thus, the tasks of resource collection, building construction, and unit making, are interdependent and require careful planning on the part of the players.

StarCraft community members shared the interest of the "metagame." In general, metagame refers to "how game interfaces with life" [32]. This is a wide definition, which includes any activities that surround a game, including game prizes, strategies, and social discourses [11]. The StarCraft community adopts a narrower version of the term, which refers only to game strategies and other preparations done by the competitors in the anticipation of upcoming matches. Henceforth, the term metagame in this paper refers to this emic definition.

Within the StarCraft metagame, other concepts are constructed. For example, a "build order" is a planned sequence of actions, including collecting resources, constructing buildings, and making units. Many build orders have been developed by the StarCraft community; and each build order confers a player certain advantages and disadvantages. As a game progresses, players gradually deviate from their build orders and adjust their actions—resource gathering, building construction, and unit making—appropriately, to gain an advantage over their opponents in battles. From this point on, a match slowly exposes the full extent of StarCraft metagame, which includes how map terrains, unit types, buildings, and resource collecting rates interact in a complex way.

Figure 1 A base sitting on a plateau with a narrow ramp.

The biography of one of the best players in StarCraft history, Yohwan Lim, alias "BoxeR," provides an insight into the importance of understanding the metagame. In 2001, BoxeR was the top player in the StarCraft pro-gaming scene for 17 consecutive months, an unprecedented feat to the nascent community. He became StarCraft's first "bonjwa," or a StarCraft superstar who had dominated professional tournaments for an extended period of time [22].

BoxeR's strategy featured an unpopular unit known as a "dropship," a slow-flying transport that carries a small number of combat units. A dropship is slow moving, and thus most players had found it unwieldy during actual matches. But BoxeR would revolutionize its uses, as he describes in his biography:

> [T]he covert dropship exposes itself in the enemy base, after having taken the unrevealed route at an unexpected moment. *Even if the opponent had predicted it, he cannot stop me*. That is my strategy. Using the enemy buildings as shields, I destroy the units and buildings one by one, but quickly, even before his reinforcements arrive. I still have a second force left even if my tired units are eliminated by the

> reinforcements. I have to defend my base as perfectly as I execute the attack. [21] (Emphasis added)

BoxerR's strategy included not just plans to attack, but also how he would have defended himself against a myriad of possible counter attacks (counters). BoxeR's speed at handling the keyboard and mouse allowed him to proficiently manage his attacks, buildings and units production, and defenses all at once, perfecting his scheme. BoxeR's strategy was well thought-out and difficult to defeat, even if the opponent had seen it coming. Such strategies emerged out of the player's hundreds of hours of analyzing and playing matches. Becoming one of the best StarCraft players is difficult, and the community developed a saying that these players need 'the finesse of a pianist, and the intelligence of a chess master.'

METHOD

Teamliquid (Teamliquid.net), founded in 2002, is the main StarCraft community site visited by players. A majority of StarCraft participants, e.g., game casters, professional gamers, amateur league participants, and event organizers, had considered themselves to be members of the Teamliquid site. Teamliquid is also a hub containing a large repository of StarCraft information, e.g., articles, online forum discussion, and weblinks.

Between October 2011 and April 2012, we performed participant observation at Teamliquid—at major and minor tournaments, bar events, and on its websites. Teamlquid.net contained StarCraft online forums and a StarCraft wiki. The online forum included edited articles of bonjwas and their landmark matches, and weblinks to videos of common player matches. We analyzed the contents of relevant wiki articles, forum posts, and edited articles. Between December 2 and December 4, 2011, we conducted field observations at an international StarCraft tournament, the North American Star League Grand Finals in Ontario, California. We attended two bar events in California.

In all, we conducted 24 interviews with pro-gamers, casters, amateur league players, Teamliquid editors, tournament organizers, and community leaders. Our interviewees ranged between 15 and 30 years old, with an average age of 21.8. There were 22 males and 2 females. There were 4 professional gamers, among whom 3 were retired but still actively involved in other community roles. There were 11 working adults, 1 graduate student, 4 college students, and 7 high school students. One interviewee did not disclose his work or school status. Other data, specifically those of BoxeR and the player "re dir," were obtained from articles and online forums in the public domain.

Skype is an Internet telephone with an instant messaging function. The interviews were conducted in person, over Skype, and on the phone. Our interviews centered on two key questions: What role do you play in the community? How do you learn to become a better player? All interviews were audio-recorded and transcribed.

We performed our analysis only on technologies mentioned by our interviewees. Some media technologies popular among StarCraft gamers, e.g., reddit and stream chats, did not emerge in our interviews. One possible reason for this could be that these technologies do not play central roles in supporting the learning of the metagame. For example, reddit as a social news site may not contain enough content on strategies.

THE FINDINGS

In this section, we will discuss how players learn the metagame. We first discuss learning through mass media like Internet TV and tournaments. Then, we discuss the practice of learning from match partners and practice partners. Next, we discuss how textual and video-based media facilitate learning. Finally, we report on how members of different StarCraft interest groups are similarly configured.

Learning using Mass Media: Internet TV and Tournaments

To master StarCraft, community members have to maintain a high level of engagement with its evolving media contents, which are centered on tournaments and competitions [7]. Michael Santos, male 29 and owner of a wine business, was a semi-professional player of another online strategy game WarCraft III. After his success in WarCraft III tournaments, he tried to compete in the StarCraft II pro-gaming scene, but he was unable to keep up with the shifting metagame:

> The game is just so fast and complex. There are counters [to a strategy] and anti-counters and counters to those counters. It's just insane how quickly the pro-game strategies change. So you get stuck watching GSL [Global StarCraft II League—the most competitive professional StarCraft II league in the world]. [You may] try strategies that GSL use versus other players doing stuff that's older. Yet, [someone else would] beat you because you don't realize the reason it worked in the GSL is that it was a counter to another strategy that was countering the original strategy.

In StarCraft, learners fall behind when they are out of touch with the community's contents and media.

Professional gamers like BoxeR are able to motivate StarCraft gamers to learn the StarCraft metagame through their performance at gaming tournaments. Mona Zhang was a college student at Princeton University. Zhang is also the founder of the Collegiate Starleague, a StarCraft II league consisting of 316 U.S. and European universities. She discussed her fascination with watching StarCraft professional matches:

> When I watched [an upcoming bonjwa] vs. Boxer, and realized that there was a Korean pro scene. It was that summer where I started

> watching pro league, and I fell in love with all the Korean players and all the eSports that was going on in Korea. You have these pro-gamers who are just constantly trying to get better, constantly toppling BoxeR. In the game that I was watching, [BoxeR's opponent] was the new legend. He ended up losing to Boxer in that set, but I think it was a premonition of what was to come, and that's the type of stuff that gives people nerd chills. And that's why I love StarCraft.

Pro-gamers like BoxeR often come out with new and effective strategies, which draw players to watch StarCraft professional matches. Many players learn by copying what pro-gamers do, as suggested by Elly, male 21, who is also a writer at Teamliquid:

> A very common advice to newbies [new players] is just to copy a pro-gamer's build. Just copy what they do, don't even think about it, just copy what they do and do it over and over and over again until you see what happens, until you see why something is useful. Mainly, I think most learning comes from kind of watching and then playing and copying.

Much of the rationale behind a good strategy come from the anticipation of what an opponent may be doing, analysis of the map terrains, and resource availability. These hidden rationales may surface as a player repeatedly uses the same strategy in a series of matches.

StarCraft learners are often preoccupied with identifying holes and gaps in their own understanding of the metagame. Thus, players who spectated StarCraft matches are often absorbed in the pro-gamers minute actions, looking for instances where pro-gamers deviated from how the players would had played the game. Novel strategies that win games are templates on which these spectators rethink their very own. Following these templates are important to good gamers who want to catch up with understanding the StarCraft metagame.

Between 2005 and 2011, Internet TV sites like BlipTV and TwitchTV were launched. Internet TV allows pro-gamers or ordinary players to "stream" their matches, or to showcase these matches live over the Internet for free and for anyone to see. Streamers with high viewership receive part of the Internet TV's advertisement profit [2,34]. Primadog, who is 22 year old, is a co-founder of BarCraft, an organized StarCraft II event where local players gather in one bar or restaurant to spectate a professional StarCraft II tournament over Internet TV. He estimated as many as 120,000 online spectators may be watching any professional StarCraft match online, at home or at a BarCraft. A player who has missed these live events can also watch the replays on video on demand sites such as YouTube.

Internet TV and video on demand have brought a deeper analysis of StarCraft matches closer to the amateur player. Using these technologies, many retired pro-gamers and expert players have streamed video commentaries (screencasts) of notable matches. Day9TV (day9.tv), that carried the slogan "Be A Better Gamer," is a website that streams screencasts of "Day[9]" or Sean Plott, male 26, who was a StarCraft Pan American Champion in 2007. Day[9] founded the After Hours Gaming League, a StarCraft II league comprised of employees from Silicon Valley companies, including AMD, Intel, Facebook, Google, and Microsoft. Day[9] shared with us the beginning of Day9TV:

> [With Internet TV] Live streaming suddenly became inexpensive and reliable, finally. Pretty much for any live event before then, bandwidth was the number one cost by far. For a big event the bandwidth you need is .5 million dollars today. Other events back then 80% of our budget was just getting our stream out. It's really weird. And then all of sudden it was free and easy. I said, "Huh, download this program and hit go and see what happens." That's almost the entire story behind the whole TV thing. This is cool, "I can do video, oh, it's free and easy."

Day[9] streamed and commented on a variety of professional matches that took place in Korea, the U.S., or in Europe. Day[9] also streams amateur matches to discuss basic practice methods and strategies. Since Day9TV was launched in 2009, Day[9] has streamed 423 videos. Most Teamliquid members suggested that each Day[9] stream had the potential to attract between 10 to 20 thousand live viewers.

Pro-gamers like BoxeR represent the community's mastery of StarCraft metagame. Internet TV and video on demand bring these practices to the players. In the next section, we examine how novice players turn this information into shared practices with their practice partners.

Practicing Together: Battle.net, LAN and Practice Partners

Good StarCraft II players practice a lot, both online and with co-located partners. Since the first StarCraft version, Blizzard has provided players with a Battle.net platform where players manually find opponents online, see Figure 2.

In StarCraft II, Blizzard automated this matchmaking process and helped players find others who are similarly skilled. The players' skill levels are calculated using the results of their recent matches. Based on each player's skill level, Battle.net assigns players into one of six leagues: Grand Master, Master, Diamond, Platinum, Gold, Silver, and Bronze. The Grand Master league is made up of the top 200 players of a particular region, e.g., the U.S. The Master league is made up of the top 2% of all players in the same region. The rest of the players are similarly ranked and divided somewhat equally into Diamond, Platinum, Gold, Silver, and Bronze leagues. Battle.net may promote the top performers of a league to the next higher league, or likewise demote the worst performers into the next lower league. Due to this ranking system, StarCraft II players have referred to Battle.net as the "ladder."

Figure 2 StarCraft Battle.net platform [24].

Brendan Ko, male 28, was a doctoral candidate at Stanford University. He represented the university in the Collegiate Starleague. He practiced online with random partners identified by the Battle.net:

> These days the StarCraft II ladder system is very good so I can meet a lot of players that are the same level with me, so I could play with them as like a practice partner, and that's all my StarCraft II playing. I sometimes play a game with my teammates [at Stanford University], but it's not actually very interesting because we already know each other very well—I can predict what my friend will do and the game will be really not interesting. That's the reason I usually play the ladder.

At a Master level, Ko was able to execute a plan correctly, anticipate and adapt to what his opponent was doing, and, at the same time, hide his own plans. Yet, that was the limit of his learning on Battle.net. Ko tried to advance in the ladder towards the Grand Master level, but the results of his matches with Grand Master level players were disappointing. Unable to comprehend the work needed to become a Grand Master player, he gave up becoming one.

Players with the ambition to learn deep practices often identify long-term learning partners, also known as "practice partners." Practice partners meet regularly on live-streams or in person to help each other improve. We interviewed Sen, a 25 year old male from Taiwan, who won third place at the international StarCraft II tournament North American Star League (NASL) in 2011. He told us the benefits of working with practice partners:

> If you practice with good players, you will improve very quickly. There are many little things in StarCraft that are easy to fix, but you do need a keen observer to tell you. They may say it using only a few words. But if you are working on your own, you may never be able to figure them out.

Practice partners spend much more time with each other than with random partners on Battle.net. Practice partners are committed to each other. They do not just play games with each other but also spend time analyzing each other's matches.

Small group learning may also take place at a LAN event. A LAN event refers to an on-site activity where video game players come together to play multiplayer games. A LAN event is supported by technologies including LAN, Wireless LAN, and the Internet. Duran Parsi, who is a 24-year-old male and co-founder of the NASL, began hosting LAN events in 2005 in California. He was then a pro-gamer. In the same year, Day[9] came to attend Harvey Mudd College located in the same state. Parsi met Day[9] at one of his LAN events, and they became friends. Thus, Parsi spent a great deal of time going over strategies with Day[9]. A LAN event allows players to exchange strategies within a preselected group of participants. Participants can exchange quick pointers. LAN events are also platforms on which participants can identify their practice partners. Parsi recounted how lucky he was to find practice partners who were pro-gamers:

> The real challenge for any player [who wants to compete at the highest level] is getting noticed, and getting good practice partners. I think there's definitely a sort of elitism among the top tier of players and they're hesitant to open up to new players and players that they don't know.

Players like the pro-gamers are entrenched in close-knit teams to sharpen their practices. Pro-gamers tend to prefer practice with other top players in Battle.net, or those whom had won tournaments.

Unfortunately, professional players congregating within tight-knit teams may accumulate knowledge that is hidden from the public media. Players like BoxeR had surprised spectators with novel strategies they had practiced in secret. In the next section, we examine how these strategies, as soon as they come to light at major tournaments, get analyzed and taken apart by the StarCraft community.

Theorycrafting: Video, Casters, and Writers

In video games, *theorycrafting* describes the process in which players reveal the game's mechanics [25]. The StarCraft community has performed much theorycrafting based on analysis of professional matches. These contents are presented in formats allowable by media technologies including Internet TVs, video on demand, online forums, and wikis. For a majority of players outside the boundaries of pro-gaming partnerships, these media can be powerful resources for learning the game. Consider how this SC player, "re dir," describes on an online forum his mind-blowing experience watching a match casted by Day[9]:

> My entire view of StarCraft, has just been flipped on its head, talk about a major paradigm shift. Beyond the unit composition, nothing seemed really out of place. Then I went on to watch [the same game casted by] Day[9]. To be frank it blew my mind. I completely overlooked [the professional player's] game plan. The things he did that seemed so unusual, now made perfect sense. I would watch a battle, and suddenly remember that I had already seen it, but it was strange, I was looking at it from such a different perspective. [8]

In StarCraft, the casters' analyses help reveal a strategy's hidden rationales. Day[9] is a popular caster because he had revealed much metagame unknown to common players.

Theorycrafting helps advance the overall knowledge level of the StarCraft community. An example comes from how StarCraft players have interacted with their keyboards. Players who can think fast, but who are unable to issue these commands on time, are unable to win matches. As such, a player's interaction with his keyboard became an important aspect of the StarCraft metagame.

In StarCraft, the keyboard keys "1" to "10" are shortcuts that can be used to quickly select units and buildings. In Day9TV's video titled "Mental Checklist: Exercises!," Day[9] suggests that players use keys "2" to "6" for the most commonly selected units and buildings [28]. These keys are most easily accessed by our left hand fingers, see Figure 3.

In the earliest days of Brood War, StarCraft players had commonly used only the mice to control every action in the game—a slow and inefficient process; however, keyboard practices are now widely known, thanks to theorycrafting by members like Day[9].

Theorycrafting produces a range of media, such as videos, forum posts, and wiki articles. Interestingly, the utility of these media for learning did not weigh evenly among StarCraft players. For example, Elly, a Platinum league player, did not read online forums and wikis for strategies:

> Sometimes I read wikis, but never the forums. I don't feel—I don't gain anything from them. Well, sometimes I'll read the original posts because they'll have an interesting build order, or they say, "Oh, I watched this game and it had a really cool build order, let me list it out for you so you can copy it." But the replies and stuff, I don't feel they're useful.

Elly found online forums and wikis useful only for researching build orders, which is similar to a procedural list of things-to-do. Build orders worked only in the first few minutes of a StarCraft match, where the opponents had not met in battles, and when game events were relatively predictable; however, as a match goes on, written procedures become less useful as game events become contingent on both players' actions and reactions.

Figure 3 Keyboard numeric keys that align well with our left hand middle fingers [3]

There are exceptions to how texts may describe complex strategies. An article, titled "The Marginal Advantage" and written by Day[9], discusses the general idea that each practice, e.g., keyboard management and build order, only confer a very small advantage to a player [29]. While each practice alone may seem inconsequential to the outcome of a StarCraft match, these practices, when orchestrated together, differentiate the winner from the loser.

Experienced players like Elly had generally relied on screencasts, rather than textual discourses of StarCraft strategies:

> The best part is you see the game. A screencast is like you actually have a teacher almost. With Day[9], he can pause a replay, he can point out things on a replay, or in a tournament he can just on the fly tell you what's behind the strategy in his experience. In many ways, people really like casters who can help them learn.

Screencasts contain videos, which are able to showcase how strategies are contingent upon match conditions, rather than procedural and stepwise. While players are watching how pro-gamers are reacting to these contingencies, casters are able to verbalize strategies that are not obvious to viewers. As a result, video-based technologies become extensions to text-based technologies when it comes to support learning among experienced players.

Other Interest Groups in StarCraft

Teamliquid contains other interest groups on the periphery of its competitive scene. These groups include the editing and melee mapmaking teams. These are highly-specialized interest groups embedded within a community, in which discourse is accented by professional competitions.

Teamliquid has an editing team that produces long articles. These articles discuss pro-gamers, tournaments, notable matches, StarCraft history, and game strategies. For example, Day[9]'s article, "The Marginal Advantage," was a product of this team. Its chief editor, known by his alias Waxangel, handpicked most of his team members among online forum posters, in particular those who were well-liked and actively contributing:

> We have people who are very, very detail oriented and want things to be very specific. We have people who are very laid back and very big picture. Honestly, it's just like, having a passion for StarCraft, being able to work hard on important things and just getting along, really, with the rest of the people who are already on staff. I can't really measure what a good personality is, but if you get along with a lot of other people on our staff, then you're probably someone everyone is going to like.

Like practice partners, the editing team is not opened to just anyone who had signed up. Players who want to become editors or writers have to first contribute actively and voluntarily in the online forums. They also had to show the ability to interact cordially with other Teamliquid members. Teamliquid editors and writers interact away from public media, in a private online forum.

Melee maps are StarCraft maps that are designed specifically for competitions. These maps differ from other type of StarCraft maps, which are essentially StarCraft mods containing games that have nothing to do with the eSports scene. The melee mapmaking community was active in Teamliquid, and contributed to the StarCraft metagame. For example, BoxeR's success with dropships was relying on his knowledge of maps, particularly the covert flight routes. The melee mapmakers designed these maps to balance the way maps would favor such well-known strategies.

Anyone who has an interest in melee mapmaking can discuss issues in the Teamliquid online forum, but the best melee mapmakers also joined one of the two teams, namely ESV and TPW. Skype provides a feature for users to invite other users into private chat channels known as Skype Conversations. A Conversation channel remains online, with its chats archived, even when channel members have logged off Skype. Members of ESV and TPW interact mostly in private Skype Conversations. An award-winning mapmaker from team ESV, known by his alias Superouman, told us, "99% of our discussions are on Skype [Conversation]."

Superouman discussed how ESV had tended to recruit only the most skilled and committed mapmakers as members:

> I can't remember even one person in a team who didn't post some maps on Teamliquid. I'd prefer determined people who would like to continue to make map for a long time. I'd also like people who take suggestions into consideration. I remember some people [in the online forums] who always ignored people's advices and even sometimes claimed they were better than the more experienced people. Everyone dislikes them.

Like practice partnerships and the editing team, melee mapmaking teams have selected members who are equally knowledgeable, equally committed, and likely to work well with others.

DISCUSSION

In this paper, we identified social-technical formations that support learning within the StarCraft community. Despite the availability of media technologies like online forums supporting mass communication and interaction, experts of the StarCraft metagame have socialized deep within private groups, such as practice partnerships, editing teams, and melee mapmaking teams. Yet, the mass media are not without learning functions. They facilitate knowledge dissemination to amateur players, so that the community as a whole becomes more knowledgeable along with the experts.

Our findings expose two functions of media technologies supporting this necessary structure of learning, comprising general learners socializing in public media on the one hand, and the highly-committed expert learners socializing in private media on the other. These functions include: (1) to convert knowledge into symbolic representations accessible by general learners, and (2) to support social practices among private groups of experts.

From Knowledge to Information: Informational media

Expert gamers, mapmakers, or editors were practicing within private social groups. At the periphery of these expert groups, *informational media* are primary sources of information useful to general learners. One unexpected, but nonetheless important, function of informational media is to entertain and encapsulate a large pool of novices to participate in common discourses within a media platform. StarCraft players like Zhang were encapsulated within the discourses of professional game play shown on Internet TV, thus eager to learn StarCraft and its metagame.

Textual media like online forums and wikis are unable to represent the full spectrum of information needed by experts like Sen; however, they are still useful in stating factual and procedural information useful to budding players. Players like Elly had occasionally used online forums to keep up to date with emerging build orders.

General learners had used public media like Internet TV and video on demand for learning StarCraft strategies. In video replays of StarCraft matches, players analyzed how professional gamers had responded to a myriad of contingency situations otherwise difficult to textualize. Digital videos are mutable artifacts. Screen casters can overlay commentaries over video streams, or pause, replay, rewind, and slow down video segments, which had helped players like “re dir” analyze a match from different perspectives. Elly suggested that Day[9] was almost like a teacher in his screencasts.

Public media, like online forums, are mostly unregulated mass-communication platforms [15]. In StarCraft, players from the levels of Bronze to Grand Masters can respond to forum discussions. Forum posts by unskilled players may not be helpful to other forum users. The experts of the StarCraft community kept their deep discourses away from these crowds, and within private groups.

From Information to Knowledge: Socially-oriented media

In-depth learning is a highly social process because knowledge resides within contexts containing our physical practices, mental practices, and technological artifacts [36,26]. The social presence of experts is important to learners, as experts can provide instantaneous guidance and feedback, which help learners solve incrementally harder problems—a necessary process of learning [40]. In this respect, a class of *socially-oriented media* facilitates social learning among experts in the StarCraft learning ecology.

Socially-oriented media are technologies which are designed to support online social interactions among a selected group of users. The purpose of socially-oriented media is to sustain small group interactions among learners, so that each learner may receive ample support and guidance from other learners. In close proximity, whether through on-site or online presence, experts benefitted from learning from other experts.

Socially-oriented media are not strictly social media. For example, many social media, like online forums and wikis, are public media open to anyone. Also, the Battle.net was designed to facilitate online competition, but was actually socially-oriented and supported the most pervasive type of social learning in StarCraft. Players like Ko had used its automatic matchmaking feature to find practice partners. In other words, whether a technology is actually a socially-oriented medium or not depends on the function it serves, rather than on its form.

For advanced players like Duran and Day[9], actual practices had happened during LAN events. LAN events as invitational events have informal membership boundaries, but nonetheless are targeted at the experts or their affiliates. For expert mapmakers and editors, private chat channels provide enclosures where they can engage in deep discussions with other experts. Mapmakers like Superouman had used private Skype Conversation extensively when working on his maps. Private channels are social tools because crowds’ opinions, whether they are uninformative or unruly, are filtered away from these interactive spaces. Within private teams, professional gamers develop new practices, such as keyboard interaction methods. Socially-oriented media construct enclosures in which learning and knowledge deepen within silos of experts.

Mobilizing Media Technologies for Mediated Communities of Practice

Unlike the novices who learned from mass media, many StarCraft experts learn in private media and from other experts. Some of our informants are members of gaming teams in other games, e.g., Warcraft III. And competitive gamers commonly migrate between popular eSport games. Thus, we believe that the learning structure we have identified is prevalent at least among interest-driven communities of competitive games.

This social-technical formation—of experts learning in small groups within online communities—is of interest to human-computer interaction. Technically speaking, media technologies have enabled any Internet user to collaborate with any other users they like, i.e., “everyone is connected.” Yet, our findings have shown that small group practices have remained important to experts, even with the availability of mass media like online forums and wiki [12].

Learners who become experts do not just rely on their technical skills. Embodied within their interactions with others are social values embraced by other experts. In practice, teams commonly admit only members who are able to socialize with others, and are open to criticism. Good learners who also display these virtues are welcome by teams, and subsequently gain cumulative advantages by leveraging the opportunity of peer-based learning within these teams. This learning activity operates outside the purview of informational media.

The social formation—of experts socializing with other experts in spaces inaccessible to novices—is not wholly different from what is described in “legitimate peripheral participation.” Wenger et al. [37] provide examples where novice learners were kept out of workspaces of the experts. These experts will share stories of what happened in these workspaces after the fact. When experts socialize using socially-oriented media, such social formations are recreated in a networked environment.

Another finding of interest is that the relative advantages of those who are privileged enough to learn in private teams suggest a new inequality in learning opportunities even on the Internet. We cannot blame the experts for developing knowledge behind closed doors. We may think that money corrupts, that professional gamers need the secrecy to maintain their competitive edge, but we have observed the same formations even among volunteers in the editing and mapmaking teams. This shows that other factors, such as small group learning being the effective and preferred way to learn for motivated learners, are influencing these social-technical formations.

A solution to this knowledge divide is to query the possibility of motivating experts to contribute information to mass media. Reputation is one major motivator of online participation [14]. And we may design systems that reward experts with compelling forms of reputation. In this respect, reputation research studies in HCI have often been framed from an information receiver's perspective: How does a user know that a piece of information given by a stranger on the Internet is reliable (see [17,31])? In this question, the information contributor takes the form of a member of the nameless "crowd," whose opinion is to be suspected. But, for the purpose of motivating experts to contribute to mass media, the research question ought to be framed from the information contributor's perspective: How can we design reputation systems that attract experts' contributions? For example, some experts may be more motivated if that reputation carries with it monetary rewards, or its equivalents, that may transform voluntary contributions into a career [19].

Corporations nurturing virtual communities should consider providing both socially-oriented and informational media to support collaboration and learning. Large-scale collaboration is not just everyone talking in the same room, but also involves experts of different interests reflecting on different facets of a community's predicaments [10]. For example, while HCI experts in a company may deepen their practices by receiving peer-to-peer support from other HCI professionals, they can also contribute information to more open forums that help management, design, and marketing professionals acquire basic HCI knowledge.

Although experts are key actors producing new knowledge, the common periphery, a public social space populated by mostly novices, is equally important to sustain learning. The periphery is where information, which experts divulge intentionally or unintentionally, diffuses into public media. The periphery is where novices may become experts, earn memberships to teams, and improve further. Expert teams are not self-sustainable, but require an influx of new experts into their memberships. From this perspective, public media are catchment media that nurture, identify, and attract potential participants into the specialized teams. The public is a relative term. To a pro-gamer, a melee mapmaker who is not a qualified practice partner is a member of the public. Thus, the periphery, the public, is also cross-pollinating knowledge between specialized groups—nurturing the learning ecology.

CONCLUSION

In this research, we anchored our interviews and observations to an interest-driven activity, and examined varying media technologies as community support tools. We found that experts do not generally pay attention to every novice participating in Internet communities. Public media, which are mass media in essence, provide for the needs of general learners. In contrast, experts had quite unequivocally opted to learn in small groups.

Based on these findings, we identified two classes of media technologies. The first is informational media, which are powerful public media that draw novices to participate in learning practices. Informational media can also re-represent complex information into formats that are accessible by novices. The second is socially-oriented media, which support the development of private channels where experts can engage in intense interaction and learning. These private channels allow for intimate social learning where knowledge deepens and is stored within the silos of experts.

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