Understanding Esports as a STEM Career Ready Curriculum in the Wild

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***Abstract*— There are myriad ways to participate in esports that go beyond just competing on a team: event organizing, legal protections, web development, shoutcasting, game analysis, and many other integral activities. These roles are paramount to the growth of the tournaments and surrounding community. They also have strong ties to science, technology, engineering, and mathematics related content and careers that are rarely made explicit, even though they develop skills valued in high tech careers at the intersection of STEM and Entrepreneurship. In this paper we present a framework for understanding the Esports Ecosystem from the perspective of diverse and divergent roles within high school and collegiate esports communities. Based on two years of qualitative participant observation of esports communities in Southern California, we detail the ways in which these forms of participation connect to valued high school academic and career ready curriculum standards that together represent STEM Entrepreneurship. It is on the basis of these connections that we have developed a year-long high school course that ties the skills esports participation fosters and the careers that they lead to.**

I. INTRODUCTION

Esports are a rapidly growing entertainment source in countries around the world. Here in the United States, these competitions are broadening to a larger audience every day. Distinct from other forms of gameplay, esports are organized videogame competitions and the infrastructure built around them. They are played by highly skilled players that train daily, are recruited to teams, and earn prize money, scholarships, and glory for competing. In fact, a growing number of universities in the United States have begun to offer scholarships to top performing esport players to compete as part of their schools team. In viewing the growth these leagues have seen, Kozachuk calculated that 344 students from 24 universities have received a collective $3M+ in scholarship tuition packages for representing their institution as a varsity player in competitive League of Legends, Overwatch, CounterStrike: Global Offensive, and other video game tournaments. They also estimated that these number would increase by the end of 2017 to 655 students across 40 universities, earning over $4.1M, although this was not verified [1]. As this number grows, we also begin to see esport competitions being held at the high school level. This growth demands attention from researchers as the participant community is becoming not only a strong economic driver, but also a more accepted form of entertainment, and even a valid preparatory ecosystem for young people entering careers and higher education. Professional players and their vocal fanbase are some of the most visible roles in esports and without them esports would not exist. The most played and well-known game in esport competitions is Riot Games League of Legends (LoL). In the LoL ecosystem, elite players occupy spots on teams that are surrounded by a host of supporting roles, including professional strategists, content creators, entrepreneurs, and event organizers. As each community practices and values its own systems of meaning, inclusive not only of language, signs, and symbols, and ways of interacting with said language, signs, and symbols. Expertise, mastery or proficiency is demonstrable by the gracefulness with which one performs their knowledge, skill and disposition of community values. Gee calls this fluency in a discourse [2]; fluency requires more than mastery, it also requires recognition of mastery within and by the community of practice. Therefore, learning is context, recognition, and socioemotional responsiveness as much as it is displaying the right knowledge in the right ways at the right time [3]. From this perspective, esports communities present interesting ecosystems for learning in their own right. The goal of this paper is to outline esports participation and its connection to STEM entrepreneurship as related to high school standards for college preparatory and career technical education. This STEM Entrepreneurship is a body of knowledge and skills that connect to high tech sector jobs not only in the games industry but also in data science, software and web development, social media marketing, and event organizing. The fandom community also contributes significant intellectual and production work that ties to academic standards and actual futures in the high-tech workforce. It is on the basis of these important connections, in collaboration with the Orange County Department of Education, that we designed a year-long course for each of the four grades of high school. Implemented in 2017, this is the first such curriculum of its kind and hopes to capitalize on students interest in esports as a way to connect and enrich their engagement in STEM entrepreneurship.

A. Literature Review

Video games have been shown to provide an environment conducive to learning in many domains. Gee theorized how games taught players the mechanics and strategies needed to play and succeed, urging educators to replicate the efficiency and engaging approach in classrooms [4]. In short, he argued that games empowered players, giving them agency

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and creating investment; they encouraged problem solving through creating scenarios in which players were driven to further their understanding of the game and its mechanics; and promoted understanding of the underpinning of the game through larger connected events. Further, Squire showed how games are a designed experience, promoting players to develop their understandings through their gameplay [5]. Steinkuehler unveiled the potential of massive multiplayer online videogames as spaces in which learning occurs fundamentally through game play. She observes discourse and play patterns that show how players learn from others in apprenticeship-type relationships and distribute cognition to pool resources [6]. There is more than ten years of work on the forms of learning entailed in games-based curricula and environments, both in and out of school. Learning in games-based affinity spaces is active [7,8], non-compulsory [9], hands-on [10], and driven by learner-initiated activities [11,12] toward a self-determined learning goal [13] that often extends well beyond just playing the game [14,15,16,17,18].

There is, however, a dearth of peer-reviewed literature within the esports domain. The existing esports literature lacks intimate knowing and critical perspective of connoisseurs of game culture [3] save Taylors work since the early 2000s, which takes an ethnographic approach to the rich description of the emergence of esports, predominantly communities located within the United States, but also internationally [19,20]. Within broader games-based learning scholarship we find rigorous, empirical studies of games that include esports titles like Defence of the Ancients 2 (DOTA 2) [21], Overwatch [22] and World of Warcraft (WoW) [23,24,25,26,27], and game world spaces like the streaming platform Twitch [28]. To date, however, there is little to no sociocultural or sociocognitive analysis of the esports scene from which to understand its import for the intellectual practices and beyond-game opportunities for participants.

B. Methods of Analysis

This work is part of a larger multi-year research project connecting esports to academic domains and career pathways. In order to understand the roles and practices of the esports community, we observed the University of California, Irvine (UCI) esports communities on campus (e.g. during day-to-day game related activities, team practices, Newbie Nights, special events, and tournaments) and within the regional area (e.g. at local esports centers and international conferences like TwitchCon and BlizzCon) for over two years and participated actively in both the game and the fandom community. Our work also included more targeted studies in the esports domain, including a cognitive analysis of UCIs collegiate esports team [29], content and pattern analysis of massive-scale (more than 10,000 concurrent viewers) Twitch channel chat [30], qualitative interviews with players (casual, elite, scholarship and professional) and viewers (unpublished), as well as survey work gauging community perceptions of esports, academics, and related activities (unpublished). Our team studied six high school esports clubs over the course of the 2017 tournament season, through focus groups and interviews with teachers, coaches and students. Additionally, our team worked with the Orange County Department of Education, and local high school teachers through several workshops to write curriculum and try out lesson plans that connect esports activities and content to California high school academic and career readiness standards. Two authors are long-time esports community members; both have been active participants for more than four years. All authors have played LoL extensively; four authors are at least Level 30 players, and two are moderately ranked players. In addition to gameplay, all authors utilized and participated in various community third-party applications, analysis forums, streaming gameplay, and conventions (TwitchCon, BlizzCon, etc) for between one and four years.

II. ESPORTS ECOSYSTEM

Fig. 1, based on a synthesis of observation of professional, collegiate, and amateur esports communities, and feedback from community members, illustrates the four main categories of roles supporting the LoL gameplay community: content creators, strategists, organizers, and entrepreneurs. While teams of competing players reside at the center of activity, it is the surrounding community roles, practices, and products that, we argue, serves as the generative engine. All roles are similar in content and relationship to other popular esports game title communities and their stakeholders.

Content Creators include a diverse and divergent variety of artists, streamers and journalists across media. Expertise is demonstrated across academic domains, skill sets, tools, and mechanisms. Participation can be through visual, written, digital, or 3-dimensional media, and can be paid or unpaid. Entrepreneurs expand opportunities and support innovation. There is a wide range of innovation and entrepreneurship in the esports space ranging from third party developer start-ups to established merchandisers and marketers to international investors with high profile teams like the 2017 League of a Legends World Championship rematch between Samsung Galaxy and SK Telecom. Strategists are community members whose main focus is in gameplay data analysis for direct improvement of a given team or character classs performance. Strategists include coaches in roles similar to traditional team sports; analysts who specialize in team strategies and dynamics; and theory crafters whose main focus is on keeping up with the games constantly evolving underlying mechanics, usually communicating to an online community found outside the game space (i.e. on forums). Finally, organizers include general managers who handle the administrative details of the teams roster, finances and schedules, and communicate with sponsors and other teams. Event managers organize competitions, and IT support sets up and manages the software, hardware and network infrastructures that make gameplay possible. Describing the esports ecosystem through this framework makes visible community labors often left invisible to outsiders and highlights the ways in which esports participation, when defined in these broader terms, connects directly to academic and workforce standards and skill development highly valued in schools.

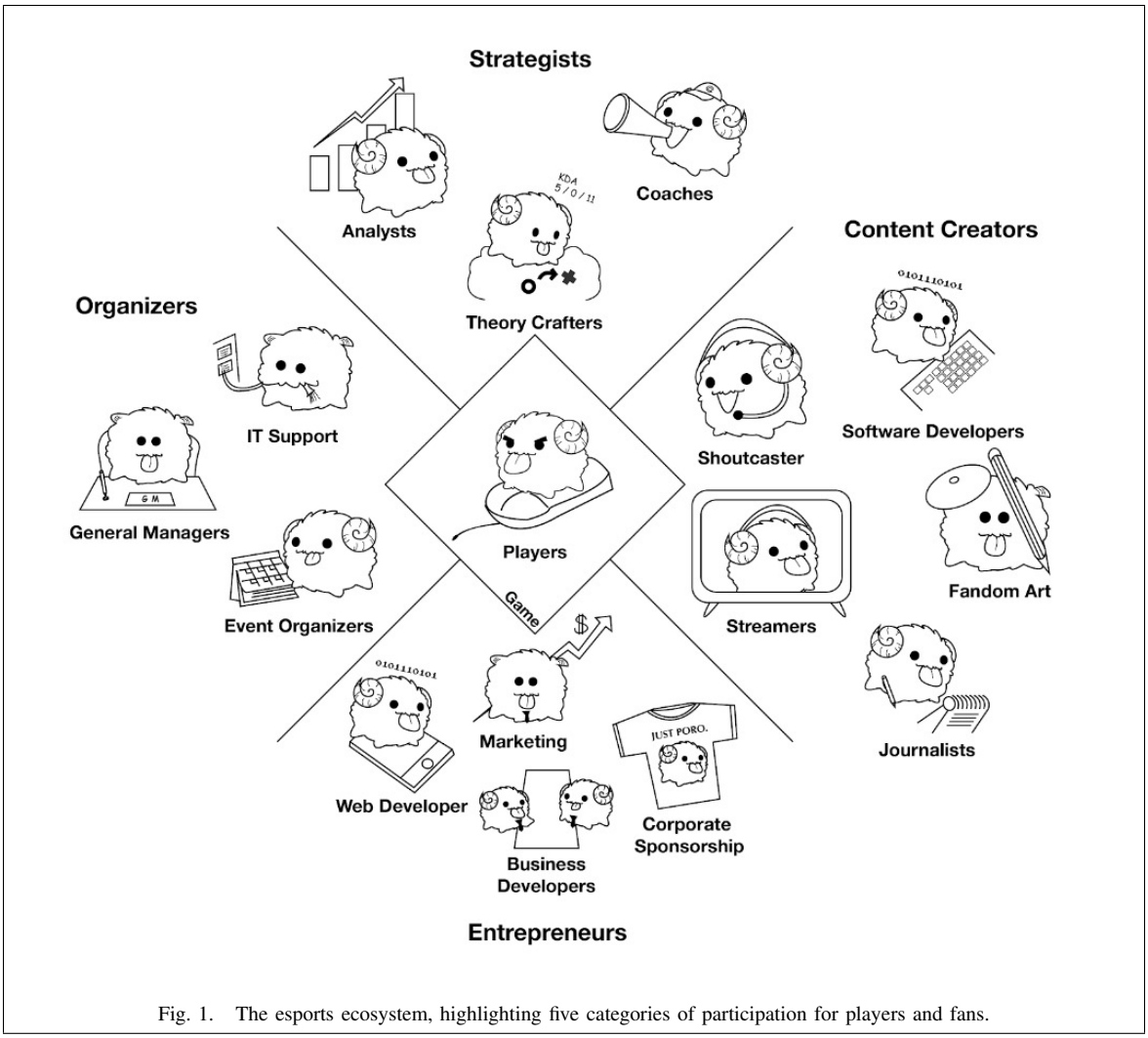

Fig. 1. The esports ecosystem, highlighting five categories of participation for players and fans.

III. ESPORTS PARTICIPATION AS STEM ENTREPRENEURSHIP

The motivation for our analysis of participation in esports is to connect students interests in this domain to broader academic subjects and career pathways. After a year of observation of the naturally occurring esports community, we contend that such labors are deeply tied to an array of career opportunities we collectively call STEM Entrepreneurship that connect to high tech sector jobs not only in the games industry but also in data science, software and web development, social media marketing, and event organizing. This body of knowledge and skills crucially connects to values high school academic (college preparatory) and workforce development (Career Technical Education) standards.

A. Esports as AP Mathematics and Data Science in action

Mathematics at the high school level commonly prepare students to understand concepts that are used in many post-secondary courses and careers. Among these concepts, students need to understand polynomial equations, interpret and rewrite expressions, reason with expressions, interpolate functions within context, and build their own functions to model relationships between different variables [31]. At the honors level, students can complete a project demonstrating their expertise with these concepts. Many of the roles within esports, including strategists like coaches, analysts, and theory crafters, require participants to demonstrate the same expertise. To illustrate this, we use theory crafters as an example. An integral part of high level competition is finding the best strategy for success. In games like LoL, players and fans often approach this in very data-driven and statistical ways. Competitive players, both professional and amateur players, use statistics provided by the game development company and web-based third-party analytic tools. We can see this emerge especially with theory crafters; individuals that take the mechanics underlying the game and deconstruct the equations to find the most efficient and highest potential strategies. These often require an in-depth understanding of how the mechanics of the game work down to the level of variable values hidden in the game code. Theory crafters look to these augments to mathematically and statistically determine which combination of mechanics will produce the most advantageous outcome across many different scenarios before testing them in-game. The level of

expertise in the game mechanics coupled with the mathematical knowhow needed to theorize the best combinations demand that successful theory crafters are steeped in the skills utilized in High School AP and Honors classes. One such theory crafter can be seen here theorizing about how to maximize a champion class skill:

> Phase rush at 75% when active with an additional 16% movement speed at level 2, 25% from Boots of Swiftness, and finally 15% from Unflinching(For some reason I have great difficulty getting the rune to trigger the 25% slow resist). Tahm's base speed is 335 plus 55 from swifties for a total of 390 though in the video I had 406 (thanks to celerity I believe for +4%). With Phase rush active I had a 308 Move speed, With Swifties and Phase rush I had 459, and with those and Unflinching active at 15% I has 498. [32]

Through manipulating the variables in the formula, one can deduce from factors that go into gameplay and how their champion classs actions are influenced by them. Such theory crafting work leverages precisely those mathematical skills required by common core high school standards in which students are asked to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flow charts, and formulas. They can analyze those relationships mathematically to draw conclusions [33].

B. Information & Communication Technologies CTE: Software and Systems Development Pathway

The Information & Communication Technologies standards for the Software and Systems Development Pathway are aimed at preparing students for careers in computer science. Web developers in the LoL community are continually producing new analytics tools for players. Those that see the most traffic, like OP.GG and LolKing.net, act as a service, constantly adding and maintaining features. These endeavors can even become full-time jobs that provide enough income to support the creator and even expand into a full company. The online tools that see the most use among players are available in mobile form due to the resource management players are restricted to when using their computers to play. For tools meant for use during play especially, this means development of mobile apps and mobile-friendly web pages and interfaces, so that they will not fight the game for computing resources and screen space.

C. Marketing, Sales, & Services CTE: C. Entrepreneurship Pathway

Streamers utilize digital platforms (e.g. Twitch, Vimeo, etc) in a variety of ways. Players broadcast their live game play as they narrate, answer questions, teach, pontificate, rant, and rave. LoL community streamers now include visual media artists who broadcast their creation process, humorists with variety shows, and even game-themed cooking shows. In 2012, Kaytoue, Silva, Cerf, Meira Jr & Rassi argued that watching video game live streams tends more and more towards becoming a new kind of entertainment on its own [35]. To be successful, streamers must examine, analyze, and develop a strategic plan for deploying these monetizing options in their channel. Forums, conferences, and live streaming with other streamers facilitate conversations around these topics with chat room viewers weighing in on decision-making. These are interest-driven STEM entrepreneurs, adopting digital tools to start, develop and maintain their own income generating communities in accordance with local, state and national, legal and financial regulations. The necessary and sufficient demonstrated proficiencies required for Twitch Partnership, meet or exceed the California standards of Career Ready Development under the Marketing, Sales & Services subsection C. Entrepreneurship Pathway. Students must [d]evelop knowledge and skills common to entrepreneurs and entrepreneurship, including the human characteristics vital for entrepreneurial thinking in a twenty-first-century global world as well as tangible skills knowledge such as creativity and innovation skills [40]. We found that students who played esports but had never streamed before, sought out support to learn, through in-person weekend workshops and online clinics offered throughout the 2018 OCHSEL season. One student, a high-ranking League of Legends player, attended an online streaming clinic and built their first streaming channel early in the season and they continue to broadcast after the season ended.

D. Esports as English Language Arts and Communication

Embedded connections between communication, literacy and interaction within esports content is in the spirit of the California Common Core State Standards English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects (ELA). At each of the OCHSEL six study sites, teachers, educational support staff [AT1] and student themselves attribute improvements in communication skills with participation in the program. One group of students explained that playing LoL as a team has high stakes around communication, with mistakes at times causes dramatic consequences that impact the entire team:

> Student 1: [T]here were times where there were big miscommunication errors where an example of something would be like... KK would come down without really much warning and we wouldnt really ask for one nor would be need one but he would gank, and we wouldnt sort of be prepared for it or like...
> Student 2: That could backfire sometimes.
> Student 1: Yeah, exactly, and the other team would probably take advantage or like he would be getting counter-jungled or something like that Yeah, communication is huge and I think we definitely learned.

The consequences then motivated improvement. In this exchange we see students meeting the ELA standards as they adapt their communication in relation to audience, task, purpose, and discipline. They set and adjust purpose for

reading, writing, speaking, listening, and language use as warranted by the task [36].

IV. DISCUSSION

Contrasted to traditional formal educational contexts and domains, learning in the esports ecosystem is active, non-compulsory, hands-on, and driven by learner-initiated activities toward a self-determined learning goal that often extends well beyond just playing the game. In this paper we explicate how esports participation connects to STEM entrepreneurship, and contend that esports is a community that natively fosters acquisition and mastery of knowledge and skills that connect to high tech sector jobs not only in the games industry but also in data science, software and web development, social media marketing, and event organizing. It is on the basis of these connections that our team co-designed a year-long esports course for each of the four grades of high school, in conjunction with the North Atlantic Scholastic Esports League (NASEL) launched in November 2017, this course amplifies the STEM Entrepreneurship content and practices of the esports scene to connect students existing affinity activities to their current academic subjects in high school and future possible careers in esports and beyond. The first year of the program was widely considered a success, and we look forward to exploring the long-term and short-term benefits that naturally occur in these interest-driven learning spaces. As researchers and educators attempt to leverage games as a vehicle for learning at every angle, teachers involved in esports clubs and activities can attest: "Theres something thats drawing them that doesnt allow them to put [the game] down, right? So, like as educators, how do we tap into that? And step one, like the closest Ive ever seen to doing that has been this League" (Teacher who participated in the first year of the OCHSEL, 2018). As esports continues to rise as a dominant form of entertainment consumption for the next generation and to attract young people to compete, stream, organize, or find whichever niche they fit, it becomes a useful vehicle for making explicit the ways that STEM disciplines are already an integral part of current passions and future aspirations. It is our position that education should be a means toward students ends; in this way, STEM Entrepreneurship becomes a hack for young adults existing aspirations.

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REFERENCES

[1] Kozachuk, J. (2017 May). 2017 Q2 COLLEGIATE ESPORTS REPORT: 40 SCHOOLS GIVING $4M+ IN SCHOLARSHIPS. Retrieved from http://tnl.media/esportsnews/2017/5/19/collegiate-esports-report-q2-2017-40schools-4million

[2] Gee, J. P. (1990). Social Linguistics and Literacies: Ideology in Discourses. Routledge.

[3] Steinkuehler, C. & Tsaasan, a.m. (2018). Sociocultural Foundations of Game-Based-Learning. In J. Plass, B. Homer, and R. Meyer (Eds.) forthcoming Handbook of GameBased Learning. (pp. X). MIT Press.

[4] Gee, J. P. (2005). Semiotic social spaces and affinity spaces: From the Age of Mythology to today's schools. In D. Barton & K. Tusting (Eds.), Beyond communities of practice: Language, power and social context (pp. 214232). Cambridge: Cambridge University Press, 2005.

[5] Squire, K. (2006). From content to context: Videogames as designed experience. Educational researcher, 35(8), 19-29.

[6] Steinkuehler, C. A. (2004, June). Learning in massively multiplayer online games. In Proceedings of the 6th international conference on Learning sciences (pp. 521-528). International Society of the Learning Sciences.

[7] Squire, K., & Jenkins, H. (2003). Harnessing the power of games in education. Insight, 3(1), 5-33.

[8] Ringland, K. E., Wolf, C. T., Boyd, L. E., Baldwin, M. S., & Hayes, G. R. (2016, October). Would You Be Mine: Appropriating Minecraft As an Assistive Technology for Youth with Autism. In Proceedings of the 18th International ACM SIGACCESS Conference on Computers and Accessibility (pp. 33-41). ACM.

[9] Martin, C. (2012). Video games, identity, and the constellation of information. Bulletin of Science, Technology & Society, 32(5), 384-392.

[10] Hayes, E. R., & Gee, J. P. (2010). Public pedagogy through video games. Handbook of public pedagogy: Education and learning beyond schooling, 185.

[11] DeVane, B. (2014). Beyond the screen: Game-based learning as nexus of identification. Mind, Culture, and Activity, 21(3), 221-237.

[12] Turkay, S., & Adinolf, S. (2012). What do players (think they) learn in games?. Procedia-Social and Behavioral Sciences, 46, 3345-3349.

[13] Choontanom, T., & Nardi, B. (2012). 13 Theorycrafting: The Art and Science of Using Numbers to Interpret the World. Games, learning, and society: Learning and meaning in the digital age, 185.

[14] Golub, A. (2010). Being in the World (of Warcraft): Raiding, realism, and knowledge production in a massively multiplayer online game. Anthropological Quarterly, 83(1), 17-45.

[15] King, E. M. (2013). Massively multiplayer online role-playing games: A potential model of CSCL@ work. In Computer-supported collaborative learning at the workplace (pp. 205-224). Springer US.

[16] Pellicone, A., & Ahn, J. (2014). Construction and community: Investigating interaction in a Minecraft affinity space. In 10th GLS Conference Proceedings,[online] Available at: http://ahnjune. com/wp-content/uploads/2014/05/Pellicone-Ahn-GLS-Final. pdf.

[17] Steinkuehler, C. A. (2006). Why game (culture) studies now? Games and Culture, 1(1), 97-102.

[18] Stevens, R., Satwicz, T., & McCarthy, L. (2008). In-game, in-room, in-world: Reconnecting video game play to the rest of kids lives. The ecology of games: Connecting youth, games, and learning, 9, 41-66.

[19] Taylor, T. L. (2009). Play between worlds: Exploring online game culture. MIT Press.

[20] Taylor, T. L. (2012). Raising the Stakes: E-sports and the Professionalization of Computer Gaming. MIT Press.

[21] Georgen, C., Duncan, S. C., & Cook, L. (2015). From lurking to participatory spectatorship: Understanding affordances of the Dota 2 noob stream. In 11th International Conference on Computer Supported Collaborative Learning. ISLS.

[22] Grothues, J. S. (2017). Competitive Action Video Games Effect on Cognitive Abilities: The Case of Overwatch (Bachelor's thesis, University of Twente).

[23] Bryant, T. (2006). Using World of Warcraft and other MMORPGs to foster a targeted, social, and cooperative approach toward language learning. Academic Commons.

[24] Dickey, M. D. (2011). World of Warcraft and the impact of game culture and play in an undergraduate game design course. Computers & Education, 56(1), 200-209.

[25] King, E. M. (2015). Designing After-School Learning Using the Massively Multiplayer Online Role-Playing Game. Theory Into Practice, 54(2), 128-135.

[26] Nardi, B. (2010). My life as a night elf priest: An anthropological account of World of Warcraft. University of Michigan Press.

[27] Nardi, B. A., Ly, S., & Harris, J. (2007, January). Learning conversations in World of Warcraft. In System Sciences, 2007. HICSS 2007. 40th Annual Hawaii International Conference on (pp. 79-79). IEEE.

[28] Gerber, H. R. (2017). eSports and Streaming: Twitch Literacies. Journal of Adolescent & Adult Literacy, 61(3), 343-345.

[29] Reitman, J. G. (2018). Do We Know Summs on Carries?: Distributed Cognition and Temporal Knowledge in League of Legends. Manuscript submitted for publication.

[30] Ford, C., Gardner, D., Horgan, L. E., Liu, C., tsaasan, a. m., Nardi, B., & Rickman, J. (2017, May). Chat Speed OP PogChamp: Practices of Coherence in Massive Twitch Chat. In Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems (pp. 858-871). ACM.

[31] California State Board of Education. (2013). California Common Core State Standards: Mathematics.

[32] Cyrosgold. (2017, Nov 9). Tahm Kench and 115% Slow Resist Live Preseason 8. Message posted to https://www.reddit.com/r/LeagueofLegendsMeta/comments/7bs0n5/tahm_kench_and_115_slow_resist_live_preseason_8/

[33] National Governors Association Center for Best Practices, Council of Chief State School Officers. (2010) Common Core State Standards CCSS.Math.Practice.MP4. National Governors Association Center for Best Practices, Council of Chief State School Officers, Washington D.C.

[34] Kollar, P. (2017). The Past, Present and future of League of Legends Studio Riot Games. Retrieved from https://www.polygon.com/2016/9/13/12891656/the-past-present-and-future-of-league-of-legends-studio-riot-games

[35] Kaytoue, M., Silva, A., Cerf, L., Meira Jr, W., & Rassi, C. (2012, April). Watch me playing, i am a professional: a first study on video game live streaming. In Proceedings of the 21st International Conference on World Wide Web (pp. 1181-1188). ACM.

[36] California State Board of Education. (2013a). California Common Core State Standards English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects