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Collegiate Esports as Learning Ecologies

Investigating Collaboration, Reflection and Cognition During Competitions

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ABSTRACT

In this paper, we explore the ways in which a collegiate esports team's play and performance underscore micro-level shifts in learning, domain mastery, and expertise through simultaneously collaborative and competitive gameplay. Specifically, with this aim, we evaluate how esports' high-stakes team play and organizational activities provide evidence of processes and practices that are important for learning-relevant trajectories in and beyond higher education. Throughout the course of a three-game match in a major collegiate esports tournament, players demonstrated decision-making, reflection and dimensions of individual and collaborative learning. We also found support for improved meta-gaming knowledge – or distributed, community-centered knowledge around the game – which underscored players' domain learning and growth. Our findings highlight evidence of perceptual learning, as demonstrated through the players' flexibility in adapting to increasingly complex challenges. We propose that these findings emphasize the importance of esports as meaningful and noteworthy learning ecologies which need to be more deeply examined in light of historic gender and racial barriers to educational and professional aspirations in gaming.

Keywords

esports, games and learning, collegiate athletics, collaboration, livestreaming, cognitive apprenticeship, equity

INTRODUCTION

The rise of gaming as a spectator sport (i.e., esports) has propelled gaming competitions and interest-driven game-based learning practices into the mainstream (e.g., Kow and Young, 2013; Richard, 2017; Takahashi, 2016; Taylor, 2012; Wingfield, 2014). While video gaming competitions have taken place since the 1970s (e.g., Richard and Gray, 2018), the past few years have seen tremendous growth, in part due to livestreaming. Figures from 2016 indicate that *Twitch*, a popular gaming livestreaming site, alone had over 100 million viewers per month (Takahashi, 2016), and estimates predict that gaming viewership will increase to over 700 million per month in 2019 (Geeter, 2018). In fact, many popular esports games, such as *League of Legends* (a multiplayer battle arena game) and *Fortnite* (a player-versus-player "battle royale" game), have millions of unique viewers, surpassing hit TV shows like *The Walking Dead* (Geeter, 2018), and generate annual revenues that are on par with traditional sports spectatorship (Taylor, 2017).

Additionally, a wealth of research over the past two decades has demonstrated the potential for commercial and educational games to engage learners and players in distributed and situated learning, problem solving, spatial skill development, systematic thinking, content area knowledge (such as history), and adaptive reasoning (e.g., Connolly et al., 2012; Squire, 2011; Steinkuehler and Squire, 2014; Young et al., 2012). Meta-analyses have found significant measurable educational benefits that favor digital games over other modes of instruction, particularly when including augmented features (e.g., Clark et al., 2016). However, scholars have found that educational and "serious" games often have limitations that inhibit widespread adoption, such as antiquated design features or limited game mechanics (e.g, simulations or puzzles) (Connelly et al., 2012), or they remain narrowly focused on a single health or educational intervention (Durkin et al., 2015). Another area particularly important for educational gaming audiences is how game mechanics involving teamwork, socialization and objectives influence relationships between distributed learning and performance of that knowledge. Collaborative gaming continues to show significant measurable benefits for learning, though the contribution of competitive elements remains contested (Clark et al., 2016). On the other hand, commercial games, though well designed for learning goals (Gee, 2007), are often more centered on entertainment, running counter to schools' aims for individual play or a brief expository approach to learning (Young et al., 2012).

However, the learning ecologies within the unique learner-initiated information spaces offered through esports need further examination. Specifically, there have been few educational research endeavors studying the learning contexts of high stakes competitive matches in Multiplayer Online Battle Arenas (MOBAs), like *League of Legends* (e.g., Kim et al., 2015). While there have been a number of notable studies on learning-relevant practices in Massively Multiplayer Online Games, most have focused on collaborative role-playing genres (e.g., Steinkuehler and Duncan, 2008). Moreover, though several studies have assessed integrating games and simulations across multiple educational and informal contexts (NRC, 2011), the learning models explored have been comparatively lower stakes than esports.

The scope of our research is especially important when we consider the historic inequities in gaming, across gender and race, particularly as colleges and high schools begin investing in esports in various ways. Over thirty years of research has documented the longstanding barriers women and girls have experienced in gaming (e.g., Cassell and Jenkins, 1998; Kafai, Heeter, Denner and Sun, 2008; Kafai, Richard and Tynes, 2016; Kiesler, Sproull and Eccles 1985), which affect equitable access to knowledge, community information and skill development in ways that would significantly impact their ability to engage in competitive play (e.g., Bertozzi, 2008; Richard, 2013; Richard, 2017). Over the past decade, researchers have found that these barriers intersect across race and ethnicity, and disproportionately affect minoritized players of color (e.g., Richard and Gray, 2018). More recently, high schools have started supporting esports competitions as a way to encourage STEM learning (e.g., Steinkhueler, 2018), and some colleges and universities have integrated esports formally as part of collegiate athletics through scholarships and dedicated facilities (Kauweloa and Winter, 2016). Other higher education institutions have allowed students to compete officially through informal channels, such as student organizations, with the school's support (Kauweloa and Winter, 2016; Wingfield, 2014), which is the case of the one under investigation herein. Given gaming's historic relationship to STEM pipelines (Cassell and Jenkins, 1998; Kiesler, Sproull and Eccles 1985; Richard, 2017) and its rising significance in collegiate pathways, it is increasingly important to understand the cognitive, social, and collaborative dimensions that underscore esports play broadly and within collegiate competitions.

In this paper, we explore the ways in which players invest in learning-relevant practices and cognitive processes through esports and livestreaming. We explore a detailed case study of one team's progression throughout a collegiate tournament as evidence of micro-level shifts in perceptual learning through simultaneously collaborative and competitive gameplay. This particular team was chosen because the players had both strong and weak ties – due to last-minute changes in team composition – and different levels of expertise (though all were sufficiently proficient for competition). To this end, we explore the following research questions: How do players engage in learning and collaboration during esports competitions? How are these interactions influenced by individual and collaborative expertise and actions? How are these interactions influenced by learning-relevant practices?

BACKGROUND

Many competitive sports offer possibilities for team play and collaborative learning. The importance of selecting top players to create high-performing teams is well established in both collegiate athletics and professional sports. In traditional sports such as football and basketball, a franchise will draft players that are expected to benefit the team. In team-based electronic sports (esports), and, in particular, Multiplayer Online Battle Arena-type games (MOBAs) like *League of Legends* ("*League*"), there are two synergistic dynamics in this respect: the players themselves and their in-game draft picks. Thus, a player's past performance is a crucial element, but in-game character drafting, which involves consideration of system patches and updates that happen frequently, also affects performance characteristics. At the time of the study (April 2016), there were 130 different "Champions" (characters); each brings something different to the game, such as abilities and characteristics that can change weekly, based on upgrades ("buffs") or downgrades ("nerfs") delivered through developer patches. Thus, while a player may be proficient with one character, his/her ability to keep up with the "metagame," or even learn different characters within a class, may be just as significant marker of his/her abilities.

Metagaming has deep roots in game studies and has more recently been used by designers to integrate gamified principles into commercial products and websites in order to drive engagement and incentivize participation through rewards and feedback systems (Kim, 2010). However, players have been creating their own metagame experiences for years, such as through "affinity spaces" (e.g., Gee, 2005; Squire, 2011; Steinkuehler, Squire and Barab, 2012) that have a wealth of fan-derived knowledge and content. More recently, the term has been adopted by the gaming community to refer to external resources, experiences and information that contribute to distributed, community-centered knowledge around the game (Garfield, 2010). Donaldson (2017) broadened this definition by proposing two expertise-related elements of metagaming: mechanical expertise and metagame expertise. According to Donaldson, a player has to attain a certain level of mechanical expertise within a game before they can start to build up a baseline for metagame expertise, or the "awareness of and ability to negotiate the game around the game" (2017, p. 440). Herein, we integrate this contemporary definition, which is akin to many of the practices and activities that foster situated learning and legitimate peripheral participation in communities of practice (Lave and Wenger, 1991).

Matches themselves represent a moment in time when mastery can be tested and, therefore, an interesting case for investigating how learning occurs when effortful practice can be analyzed. Before the match begins, teammates collaboratively decide on their best strategy. This includes (a) choosing champions that each individual player can play effectively, (b) negotiating which champions work together based on individual skills and team-balancing needs, and (c) banning other champions, which would strengthen the opposing team. This has been described as the proficiency-congruency dilemma, a framework developed from research on organizational behavior and team dynamics (Bardzell et al., 2008; Bradley et al., 2013; Cohen and Bailey, 1997; Kim et al., 2016). To effectively compete in popular MOBAs, a team must make collaborative decisions before, during and even after a match, since most games are played as the best of several matches. Team members speak candidly to one another and gain expertise by addressing this dilemma through consistent gameplaying and by reading forums, keeping up with and evaluating patch notes, and watching professionals. In other words, more experienced players have gained an understanding of the intricacies involved in play, such as choosing characters based on anticipated or actual complexities that can occur.

Research shows (Kim et al., 2016) that teams that are better able to prioritize team proficiency (i.e., expertise with the character roles needed on the team) instead of individual proficiency (i.e., individual expertise with certain characters) perform better, as do teams that have good congruency, or group cohesion. Congruency is achieved by matching the best roles needed by the team and with the characters available for the team. Unsurprisingly, players with more expertise are better able to have both high individual proficiency and team congruency because they have developed "superior mental models of how in-game roles complement each other [which] novices have to develop . . . over time" (Kim et al., 2016, p. 4359). Research shows that when teams balance individual and distributed roles and skills, they will outperform teams that lack this cohesion (Kim et al., 2016; Goodman and Shah, 1992; Huckman et al., 2008). However, unfamiliar teams and blended teams with expert and novice players can partially bridge the gap through discussion.

The proficiency-congruency dilemma extends upon deliberate practice (e.g., Ericsson, Krampe and Tesch-Römer, 1993), which describes how people become experts in their chosen fields through extensive and effortful repetition and training. Specifically, studies of athletes find that, unlike their less experienced counterparts, experts are more likely to engage in targeted effortful practice on their weaker skills rather than their stronger skills, which results in measurably significant improvement that holds over time (Coughlan et al., 2014). In other words, the more one engages in deliberate practice, the better one will comprehend and predict the intricacies involved in play, such as choosing characters based on anticipated or actual complexities that can occur. To further this argument, players' evolving expertise is coupled with developing and refining heuristic techniques around champion interactions, mechanical play, and larger metagame team strategies, which are dependent upon both consistent practice and community engagement.

In the research literature, little is known about collegiate competitive game-based learning, which can be simultaneously informal and formal. One area in the growing body of research on collegiate esports explores how formal or informal university support affects players' perceptions of esports as work or play (Kauweloa and Winter, 2016); findings illustrate support for Stebbins' (2007) construction of "serious leisure," which describes activities that distinguish themselves from casual activities, in that they have social, professional and identity benefits, and in which they require effort and skill development. Kauweloa and Winter's (2016) analysis of a formal, structured, scholarship-based university model versus an informal, student-organization university model found that both could enhance players' self-image, self-expression and self-actualization, but that players in the formal model demonstrated slightly stronger confidence in their identities as competitive gamers.

In many ways, informal collegiate esports organizations work like communities of practice (Lave and Wenger, 1991), and the communities of practice framework has increasingly been utilized to document game-based learning through communities (e.g., Kow and Young, 2013; Richard and Gray, 2018; Shaffer et al., 2005).

Jean Lave and Etienne Wenger (1991) originally coined the term "communities of practice" (CoP) to refer to the "legitimate peripheral participation" that occurs in hobby and practitioner communities. The CoP framework integrates situated learning, which is meaning-making produced with others in social and contextual practice. For example, members of the esports student organization under investigation gathered at weekly meetings to discuss patch notes and strategies. More proficient players offered advice and training to newer players. They also engaged with media platforms such as *Discord* to facilitate team chats and *Facebook* to share ideas surrounding gameplay. Furthermore, they utilized livestreaming, primarily through *Twitch.tv*, to broadcast their team play and reflect on it, as well as learn from other players' strategies.

Four team-level interpersonal beliefs can affect learning behavior: psychological safety, cohesion, interdependence and group potency. Psychological safety indicates a collective belief that the team is safe for interpersonal risk taking (Edmondson, 1999). Task interdependence refers to interconnections between sub-tasks that contribute to overall group performance (van der Vegt, Emans and van de Vliert, 1998). Since sub-tasks are dependent on each other, task interdependence can lead to open and effective communication between team members. Outcome interdependence refers to team members' "personal benefits and costs" being tied to "successful goal attainment" by other members of the group (van der Vegt et al., 1998, p. 130), similar to team and individual proficiency and congruency. Cohesion has two dimensions: task cohesion and social cohesion. Task cohesion, which leads to better learning and performance behavior, refers to the collective effort by all members working collaboratively towards completing an enjoyable and motivating task, whereas social cohesion reflects and is dependent upon the emotional bonds between team members. Group potency describes the shared belief in the group's effectiveness, which has been shown to increase performance and satisfaction (Miyake and Kirschner, 2014). Miyake and Kirschner (2014) suggested that collaboration requires not only construction and co-construction of meaning, but also constructive conflict to create mutually shared cognition. For example, criticism is often voiced by less experienced individuals, but prompts better strategies and explanations by more knowledgeable ones.

Players can also engage in reflective processes of comparison and improvement. There are two primary forms of reflection: abstracted replay, which occurs when individuals look back at their own performance (Collins and Brown, 1988) and perceptual learning (Bransford et al., 1989), in which learners hone a specific set of skills. This form of cognitive apprenticeship typically happens through various forms of replay and contemplation, and gives learners greater flexibility in adapting and transferring their skills to different contexts and domains. Of particular interest to our investigation are learning theories that highlight the ways that knowledge occurs in, or is applicable to, real life, thus suggesting applicability for near and far transfer to other learning or performance contexts. Cognitive apprenticeship (Collins, Brown and Newman, 1989), for example, is derived from models of traditional apprenticeship and sports, and emphasizes cognitive rather than physical skills. Through cognitive apprenticeship, one initially begins learning complex physical skills through imitation, such as when a coach or expert demonstrates how to perform an action. However, the theory of cognitive apprenticeship further suggests that there are three major forms of reflection that can significantly affect learning, for which multimedia technologies provide unique advantages: replay, when a coach videotapes a player’s actions and compares them to those of experts; abstracted replay, when a coach focuses on specific critical points of action; and spatial reification, which happens when several critical points of action are mapped out over time so a player can see his/her learning progression. Perceptual learning, on the other hand, is thought to happen over time through different reflective processes that help learners to flexibly adapt to complex challenges (Bransford et al., 1989). Over time, the complex interplay between these forms of replay and learning allow for mastery or expertise development to occur. While these developments happen at an individual level, they also occur at a group or team-level through consistent practice and collaborative play. Negotiation between differing or “blended” expertise is fundamental in establishing powerful moments of team-based reflection.

Summary of Learning Theories

In summary, since we know that higher skilled players and teams are better able to navigate the proficiency-congruency dilemma (or deliberate practice), we used this framework to understand both decision-making and domain mastery. Due to the mixed expertise of the team under investigation, we expected to see the following: (1) interactions based on blended expertise, which should lead to more discussion and negotiation; (2) instances of reflection within and between matches; (3) heightened task interdependence leading to more open communication; and (4) micro-level shifts in effective individual and collective performance. As this was a newly formed team in a tournament (or high-stakes performance domain), we also expected to see more outcome interdependence, which would improve over time. Due to the event being high-stakes, we anticipated that the team would exhibit high task cohesion. Finally, we further expected to find more risk-taking if the team members felt psychologically safe, and greater group potency (or self-efficacy) as their performance and team dynamics improved, which would lead to perseverance against the odds.

METHODS

Data Collection and Analysis

Data sources included participant observation, both during physical club meetings and tournaments, and during online streams of practices on *Twitch.tv*. We focus herein on a subset of data collected during a collegiate esports tournament. The following analysis is a case study of a match between “Team

B" and "Top Big East" in the *2016 Home Institution Collegiate Esports Tournament* (we have given pseudonyms for the sake of confidentiality). We video recorded the interactions of Team B during the tournament, and two members of the research team analyzed the data for themes, utilizing constant comparison analysis techniques (Strauss and Corbin, 1997). Specifically, two coders (authors McKinley and Ashley), after being trained by author Richard, analyzed similar parts of a subset of the data (two games) and transcription using open coding techniques, followed by discussion and negotiation of codes with all three authors. After the axial codes were negotiated, all of the data was recoded with the axial codes. We analyzed a subset of the data (20 minutes of the three hours of video), finding that most codes were in agreement (Cohen's Kappa = 0.67; 83% agreement). All team members then reviewed the video data with the axial codes, followed by analytic memo writing. Themes were derived from the collective fine-grained analysis of the data, codes and analytic memos over several team meetings. Findings were also checked by other researchers and *League* players (n=3), who sat in during some of the group meetings and verified thematic connections.

Participants and Setting

One team, made up of five participants (herein, "Team B"), was observed during a major collegiate tournament hosted by their home institution. A total of four teams from the home institution competed, along with four teams from universities across the United States. This particular institution did not have official support for esports, and instead maintained their collegiate esports status through a student-run organization, thus illustrative of an informal university model, according to Kauweloa and Winter (2016). Other competing teams were from institutions with both informal and formal scholarship-based university models.

As college students, team members sometimes had to skip practice or withdraw from teams in order to deal with other pressing matters such as schoolwork. When Team B entered the LAN, the members were not well practiced as a team. While the university utilized an informal model, the esports student organization maintained a “Division 1” (herein, D1) team, a recognized top team that officially represents the university at national esports tournaments and events. At the time, the student organization independently organized esports representation for the university through several national collegiate esports networks, many of which required one official team. The D1 consisted of highly ranked competitive players in the organization who had competed for their placement. The D1 team also maintained a manager, coach and two analysts, who were all unpaid club members, and attended weekly coaching sessions where they examined competing teams’ strategies, evaluated the D1 team’s performance at the individual and group level, and focused on areas for continued development. Thus, in many ways, the informal model mirrored the formal model, without scholarship support or facilities.

However, the student organization also supported other teams, characterized as “Division 2” teams, that could compete in certain national tournaments, when multiple teams were allowed, or in university-hosted tournaments. Team B was a D2 team without the tailored support dedicated to the D1 team. Team B was largely considered to be the underdog of the tournament because it had formed only shortly beforehand due to another team disbanding. In particular, one team member (given the pseudonym “C5” herein) served as one of the organization’s leaders for the *League* division, but was not originally on any of the competing teams, though he was widely regarded as knowledgeable and capable of filling the empty position. It should be noted that, unlike the other Team B players, who were at the diamond level (i.e., top 2% of players nationally), C5 was at the platinum level (i.e., top 8–9%); thus, this player was regarded as highly competitive, but perhaps in a lower tier than most of the players in the tournament. We chose to focus on Team B because the members were blended in expertise and, perhaps as a result, were the most vocal during the tournament in describing their interactions, thus providing a salient case study of the kind of learning-relevant practices observed during collegiate esports play.

The tournament was hosted on campus at the home institution. During play, competing teams were separated into meeting rooms with a referee assigned to each room (see Fig 1). Spectators watched the entirety of the tournament from an auditorium in which the gameplay was projected on a large viewing screen as it was livestreamed on *Twitch.tv*, with commentary provided by broadcasters—many of them students honing their sportscasting skills at the same time. We focus here on the interactions in the room where Team B played, and where we set up a camera and microphone. While these cameras were checked regularly between matches, the researchers were not in the room while the competitive matches were played, in order to limit interference. We labeled each participant from C1 to C5 based on their distance from the camera (see Fig 1, bottom). Each players' seasonal ranking can be found in Table 1.

Figure 1: Left: Picks and Bans phase; Right: In game. Study Participants (closest to furthest): C1 – Tank (Top Laner); C2 – Jungler; C3 – Mid Laner; C4 – Attack-Damage Carry (ADC); C5 – Support / Team Captain. Referee stands behind them.

Position (Player)	Season Ranking
Top Laner (C1)	Diamond
Jungler (C2)	Inferred at Platinum or Diamond (Unable to locate)
Mid Laner (C3)	Diamond
ADC (C4)	Diamond
Support (C5)	Platinum

Tiers from the lowest to highest (percentage of total players in each tier in parentheses): Unranked (N/A); Bronze (25.40%); Silver (39.15%); Gold (25.05%); Platinum (8.41%); Diamond (1.95%); Master (0.03%); Challenger (0.02%).

Table 1: Participants' solo queue season ranking during the tournament (April 2016; Season 6).

Game Setting

In *League of Legends*, two teams of five champions battle it out. The goal of the game is to march to the other team's base with your fellow teammates and minions to destroy the enemy's Nexus (see mini map in Figure 2). The players control a character known as a champion, of which there were 130 as of April 2016 when the data was collected. Each champion assumes a different role: Marksmen/Attack-Damage Carry (ADC), Mid Laner, Tank, Jungler and Support (see Table 2).

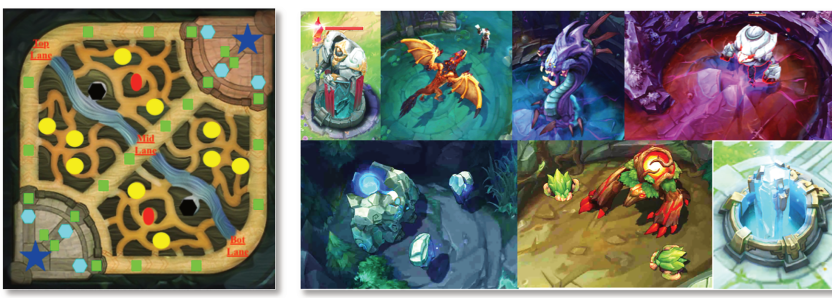

Figure 2: Left: Mini Map of Summoner's Rift (Nexus: Blue Stars; Turrets: Green Squares; Jungle Camps: Yellow Ovals; Dragon/Baron: Black Hexagon; Inhibitor: Blue Hexagon). Right: Objectives, Left to Right: (Top) Tower, Dragon, Baron, Rift Herald, (Bottom) Blue Buff (Dark Blue oval), Red Buff (Red Oval), Inhibitor.

Position	Position Description	Example Champions	Category
Tank **Top Lane**	This is typically a solo lane filled with characters who are specialized in very high health, armor and/or resistance to magic.	Malphite, Trundle, Rammus, Ekko, Nautilus, Poppy, Graves, Vladimir	Tank, Bruiser
Mid Lane	This splits the battlefield in half. It is filled with champions, who use their powers, or Assassins. It has a high impact early on and mid-game.	Zed, Vel'koz, Ekko, Kassadin, Annie, Ahri, Azir, Talon, Vladimir	Mage, AP Carry, Assassin
Jungle	This takes up most space on the map. Champions in the jungle are very mobile and constantly look for easy ambushes.	Graves, Hecarim, Trundle, Kha'Zix, Kindred, Vi	Jungler (almost any role)
Attack-Damage Carry (ADC) **Bottom Lane**	Comprising one half of the bottom lane, the ADC is responsible for killing minions (farm), dominating the enemy ADC, and supporting the building of powerful late-game items.	Graves, Ezreal, Corki, Ashe, Vayne, Tristana, Jinx, Twitch	Marksman, Assassin, ADC
Support **Bottom Lane**	Support keeps the team alive and frustrates the opposition. This is accomplished through slows, stuns, heals and shields.	Braum, Malphite, Morgana, Nautilus, Brand, Sona, Soraka	Tank, Support, Mage

Table 2: Champion Roles and Mechanics in League.

As one can imagine, there is a complex interplay between the champion roles, and certain characters may even swap roles through the course of a match. The mechanics of play are also quite intricate. Each champion has four skills, which are mapped in a similar way to the Q-W-E-R keys on the keyboard. Each skill has a different effect, and the "R" skill (or "Ultimate" ability), when used effectively, can transform the game.

Once a player is in control of a champion, she/he must plan out a build path for itemization. *League*, at the time of this study, had about 200 separate items to choose from in any one match. This helps illustrate the complexity of decision-making that any player with a single champion alone would need to make in order to be successful. However, items are needed, not only to maximize a character's effectiveness, but also to balance the team's choices and counter the enemy team's build path. Finally, due to the nature of strategic team play and coordination, communication is the backbone of successful game outcomes. *League* facilitates communication via an in-game ping system through which players can signal information to their teammates with the click of a mouse, and chat via a window when more detailed messaging is needed. This is further enhanced by utilizing popular team communication platforms such as *Discord*, which can be used for both text and voice chat from a distance or while in the same room.

Preparing for a Match

Before the match is played, both teams must draft their champions. In *League* Tournament Mode, there are three phases of drafting: ban phase, pick phase and trade phase. Each team receives three bans and has thirty seconds to decide which champion to target, proceeding in an alternating fashion. In the pick phase, a team has sixty seconds to choose a champion. The order is A/BB/AA/BB/AA/B, where A represents Team 1's pick and B represents Team 2's pick. Once a five-champion roster is selected, each team is given sixty seconds to trade champions within their team. This enables changes based on both individual abilities and team balancing, as well as advanced strategizing around the champion pick order to counter potential enemy picks. Once in game, players are able to view other players' profiles for information such as their rank and their most-played champions. Profiles can provide immediate feedback for the purpose of last-minute strategizing and final preparations.

FINDINGS

In our analysis, we focus on Team B's progression from game 1 through game 3 against a more favored team in the tournament. The tournament matches consisted of the best of three games. During this match, Team B won games 1 and 3, and progressed forward in the tournament, which they eventually won against a different favored and significantly higher ranked team from an institution with a formal, scholarship-based university model. We begin by focusing on changes in their drafting strategies over time, followed by interactions across the games during the match.

Drafting Strategy Progressions

Team B's first significant interaction begins before the drafting phase of game 1, when the team is still setting up their equipment. While this is happening, the team begins to discuss their pick and ban strategies. As this conversation progresses, the Jungler (C2) asks if anyone knows what champions their opponents play. This prompts the Top Laner (C1) to investigate the opponents' player profiles and point out a champion that one of them favors. The Jungler (C2) encourages them to look at the opposing team's match history in the hope that it will provide critical strategic information. C1 points out another champion that the other team will probably pick, and C2 quickly questions whether the character should be banned.

> **C1**: One of them plays Malphite [*viewing opposing player's Summoner profile*].
> **C2**: Yeah, look at their history.
> **C1**: He plays Aurelion.
> **C2**: Should we ban Aurelion, just to troll him?

In particular, this exchange reveals important aspects of the proficiency-congruency dilemma. For example, if the team knows what their opponents are comfortable with, denying the option to play as those champions may reduce their effectiveness. By knowing who their opponents are likely to play, the team can begin crafting strategies for countering those particular champions.

Through the first game of the match, the players were observed refining their strategies and the synergies amongst the team. In game 2, we saw two new developments during drafting. The first was the confidence Team B members got from their game 1 win. C3 stated that he wanted to play a direct counter match-up. C4 questioned this by asking if C3 had something to prove. C1 suggested that C3 should play the champion that his opponent had just played if he truly wanted to make a point. C1 and C3 briefly discussed what this match-up would be, and as C1 reviewed this strategy, he realized that it might work:

C3: I feel like playing a direct counter matchup just cause . . . I don't know.

C4: Why, just to prove a point?

C3: Yeaahh

C1: You want to play, umm uh, whoever they played. I don't remember.

C3: Ari

C1: Yeah, against an Azir.

C3: Maybe

C1: That actually sounds like it would be pretty good for Ari's . . . charm until he ults.

A common strategy is drafting for team synergy, where all five champions have a good balance between them (congruency). Otherwise, a player can play toward his/her individual expertise (proficiency). In this case, we saw C3 wanting to show his skill and to challenge his lane opponent personally by playing a direct counter character. C1's suggestion would make a bigger point if C1 played the same champion his lane opponent had just played and won the lane in order to demonstrate his expertise over his opponent.

The second development in game 2 was that both teams could integrate information learned from game 1 into their drafting strategy. Their strategies towards picks and bans changed based on what worked well in the previous game and what did not.

During the drafting phase, we saw Team B react to Team Big East's banning decisions. For instance, in game 1, Team Big East banned the champion Poppy. This could have been done because they felt Team B had a strong Poppy player, or that she might have been overpowered in the current meta. However, when Team Big East chose not to ban her in the second game, it raised strategic questions for Team B, such as whether they wanted to use her themselves.

> **C1**: Okay, Kindred bans.
>
> **C2**: That makes sense.
>
> **C1**: They didn't ban Poppy like they did last time. I don't know if any of them play Poppy, or we could just go for . . . what do you think?
>
> **C5**: I think we should ban Poppy, like cause like you guys don't seem to be afraid of anybody, so just hover Poppy.
>
> **C2**: Yeah
>
> **C1**: Okay so ban her?
>
> **C5**: Yeah like who else are we going to ban?
>
> **C4**: I mean, it's bad if we ban more, honestly, cause we're purple side, cause like, if we leave one pick open, we have less to choose from.
>
> **C4**: We might get Nautilus again, who knows?
>
> **C1**: They might go for the CC again.

In game 1, the team made more predictions of what the opposing team would play based on their Summoner profile, whereas, by game 2 and certainly in game 3, there was a more in-depth discussion surrounding the new knowledge they had over the previously played games. For example, as we see below, during game 3's picks and bans phase, Team B began debating a choice for the ADC on their team during their sixty-second window. They reflected on the previous game, focusing on how their team composition seemed to counter the enemy's when proper execution techniques were utilized. C1 mentioned that they tried to "peel" (i.e., protect their ADC from) the enemy, Morgana ("Morg"), but alluded to the strategy being unsuccessful in the prior game (game 2). Finally, in order to pick the proper ADC, Team B needed to determine who the enemy Top Laner/Tank was likely to pick and set up an effective counter-ban.

> **C2**: Is there an ADC that can kill tanks really well? Like Corki?
>
> **C3**: You play Vayne, just play Vayne.
>
> **C4**: Vayne's not that good at (. . .)
>
> **C2**: Corki he's . . .
>
> **C1**: There's Lucien, Lucien is pretty broken.
>
> **C2**: Corki with BotRK.
>
> **C3**: They were doing the double AD comp last game, like, where do they go,
>
> like . . .
>
> **C3**: They would do all the initiating, we just had to pick em like Malz would peel Morg.
>
> **C1**: Idk I tried, like . . . idk.
>
> **C2**: Did we ban Poppy?
>
> **C1**: Yeah because, well, I don't know if their Top Laner plays Poppy . . . . I don't see him playing it.

> **C4**: Yeah, let's just see what he plays first. He picked Trundle last game, right?
>
> **C1**: Umm, he played Trundle, then Malphite.
>
> **C1**: We aren't planning on banning Malphite, are we?

In this exchange, we see fundamental changes from game 1 to game 3. For example, during the champion selection phase, the team presented more confidence in their decision-making by applying knowledge from prior games to make informed predictions of the enemy's picks. In particular, we start to see elements of refinement in their group potency (i.e., collective self-efficacy), which, in turn, leads to modifications in their strategies for picks and bans. In many ways, group potency highly influences task cohesion, which occurs when learners collaboratively work toward completing a task, and is connected to better learning and performance. Thus, these improvements in performance could be considered a benefit of their effective and distributed collaborative learning. We also see specific instances of reflection, when team members discuss the previous team composition as well as the successes and failures of countering the enemy's strategy.

From Individual to Collaborative Reflection and Perceptual Learning

Dedicated players, particularly those competing formally or informally, spend several hours each week attempting to improve their gameplay, either through formal team practice or analyzing past matches on *Twitch.tv* or *YouTube*. In other words, they engage in reflection techniques such as replay or abstracted replay in order to compare their strategies to those of experts. When game 1 ended, the players were allowed to use their web browser. Realizing that the game was being broadcast on *Twitch.tv*, the players quickly tuned in to the livestream. The stream was showing footage (on a built-in delay to prevent cheating) of one of the bigger team-fights during the match. C4 (who died during the fight) pointed out the instance in which he attempted to heal his character, but for whatever reason was not able to. He knew the moment in which he needed to heal, but was unable to complete the action, blaming technical issues.

> **C2**: Are they casting?
>
> **C4**: Oh, look right there . . . . *[points to screen]* I couldn't heal! The f—! Literally my screen froze!

By honing in specifically on one action, we could argue that he was engaging in abstracted replay. In this particular case, he did so individually; thus, while he may have learned from the exchange to improve his individual performance (i.e., individual proficiency), his team was not integrated into this process. By game 3, however, the team engaged in a collective review of a past game where there were errors in team-fight execution:

> **C3**: I should have went Kha'Zix.
> **C4**: Dude Malphite was going on you then.
> **C3**: No. I was watching for the ult. I was back far enough. Ezreal just ulted me, so I'd say yes.
> **C4**: *[Laughs and shakes head]*
> **C3**: The laser worked pretty good.
> **C4**: *[Laughs]*
> **C3**: The same thing.
> **C5**: *[Claps]*

In the exchange, we see that C3 was questioning his champion pick in the previous game, saying he should have gone with Kha'Zix, based on the gameplay. Yet C4 did not agree because the enemy tank, Malphite, was focused on C3 for the game, and Malphite would have countered Kha'Zix in that match-up. Paying attention to the screen where he was watching the replay of their last game, C3 explained the rationale for his actions: "No, I was watching for the ult. I was back far enough. Ezreal just ulted me so I'd say yes." By moving from individual abstracted replay to team abstracted replay, there is evidence they were engaging in a holistic review that capitalized on their shared expertise. As a result, they could collaboratively correct their shared schema through discussion, in order to heighten their team proficiency and congruency. In many ways, the team's heightened congruency can be argued as a byproduct of subtle yet distributed shifts in perceptual learning happening through reflection and discussion.

Risk Taking and Psychological Safety

Throughout the following exchange during game 3, there were many instances elicited where members were able to ask questions, test strategies, and enact risky maneuvers for the overall benefit of the team. For example, the exchange below shows the team members communicating their plans to push out their lanes to take the next tower. While this was happening, the team got vision on the enemy, Hecarim, and the Mid Laner (C3) attempted to destroy him. C3 ultimately took a risk in attacking Hecarim, but ended up failing because he was stunned and exhausted (i.e., his damage output was reduced). Killing Hecarim would have provided the team with more time to be aggressive and push out their lanes more safely, a key strategy for successful game play.

C3: I think we're fine.

C5: We have vision.

C4: Switch, switch

C2: Alright, he's going to try and come in.

C4: Just shove in, shove in.

C3: Shove down work mid.

C5: Yeah, we're shoving.

C2: I'm going to go get the, uhh . . .

C2: Hecarim's at blue.

C4: You can go warpath if you want.

C5: Hecarim's right there, sitting gromp.

C2: You gonna go in?

C3: One second

C2: You gotta go in and kill him.

C3: Omg

C2: I thought you had him, dude.

C3: I got like, stunned again.

C3: Yeah, I was exhausted so . . .

C2: Oh, you were exhausted.

C3: Yeah

C2: Oh ok, that's why.

C5: Let's just stay there, hold blue.

As seen above, not all risks pay off. The Mid Laner (C3) failed to capitalize on destroying Hecarim. Individual players often make risky decisions without team consensus. However, in this case, we see that C3 was pressured to go against Hecarim by C2, perhaps at a time where he was not entirely ready for the exchange. Teams benefit when players can take risks, fail and still be supported by their team. In the exchange below, which occurred after the completion of the game, team members started poking fun at the Mid Laner (C3) for having the most deaths (i.e., "feeding" the opposing team).

C3: Oh, my god.
C2: Dude, why did our Zed feed guys?
C5: Way too much feeding, bro.
C4: [*Looks at C3's screen and laughs*]
C4: Nice feed! Four times! That's 80% of our deaths [*Laughing*].
C3: [*Laughs*]
C3: Oh, my goddddd, yeah 80%, oh, my god.
C2: Omg, Maokai, did so much damage! Holy crap.
C5: Alright, good win. That's what I like to see!

An assassin champion, like Zed, is inherently risky to play due to its ability to dive into the backline of an enemy team. This can strand a player from his/her own teammates, but it also has the ideal outcome of eliminating one or more high-threat targets. Here we see the majority of the team poking fun at C3, the Mid Laner, who had four deaths in this match. Due to how well the other players performed, four deaths equaled 80% of the total for the team. However, this good-natured teasing acts as a form of implicit communication and reflection that helped highlight the enjoyment of the task of gameplay in competition.

C5: That one Zed snipe that you had where you picked off the Ezreal,that's what we needed. It helped us a lot.
[C3 and C4 laughing]
C2: This one here?
C5: Yeah, because Hecarim panicked and he went in . . .
C4: Wait, wait – I was back in the bush with the Brand where he flash-Q'd me!
C4: Then the Nautilus TP behind.
C2: The second they don't have a Maokai, it's safe.

In order to ensure that team morale and individual player worth were fostered, the Support (C5) pointed to a specific instance in a team-fight toward the end of the match. In this fight, C3 was able to perform his role effectively by eliminating the opposite team's ADC, Ezreal. In doing so, C3 was able to swing the encounter in Team B's favor and allow for a clean fight that led to winning the match. This is important to mention here because, while the teasing was amicable, C5 felt that it was necessary to show the rest of the players that C3's contribution and performance were integral to the team's success. In fact, C5 served as the team's support champion, both figuratively and literally, throughout the tournament. In other words, by helping refocus the team on their individual and collective strengths and by reinforcing positive exchanges, C5 helped ensure psychological safety, which, in turn, reinforced both their group potency and risk taking.

Group Potency and Self-Efficacy

In a high-stakes, collaborative performance, the belief that the group is powerful and can adapt to problems encountered is vastly important to its success. While the team elicited several instances of group potency, one of the more powerful instances can be found right before game 3 began:

> **C2**: What if it's a Nautilus Jungle?
>
> **C3**: Nah, it will be Hecarim.
>
> **C1**: I think it's going to be Nautilus support again.
>
> **C2**: We're doing Zed?
>
> **C3**: Yeah, I feel like Zed is good. 'cause I feel like they can't initiate, if I can dive.
>
> **C1**: I have confidence in you, you can get onto someone important.
>
> **C2**: Plus, we need an Assassin.
>
> **C3**: Yeah, I can pop to the backline, so…

> **C2**: So, Zed will kill the backline and me and (. . .) will just kite out their . . .
>
> **C1**: Peel the Hecarim off the Corki and everything.
>
> **C2**: They got Morgana support, that's fine, no big deal.

This exchange occurred in the pick and ban phase, prior to the beginning of the match. The conversation above was built upon the previous win in game 1 and loss in game 2. Here, one can see the team members building confidence in one another around their individual skills with champions, as well as their overall need as a team to have a champion that can eliminate important enemy champions. Beyond the importance of C3's pick of an Assassin champion, it can be observed that they are confident in their ability to "kite out" the enemy and "peel" for their ADC, Corki. These are integral mechanics to keep their most important champions alive to influence team fights and ultimately come out on top in exchanges.

Individual and Collaborative Performance and Task Interdependence

For the most part, the interdependence on task and outcomes occurred at nearly every point in the game when the team members were coordinating an attack on a major objective. As a reminder, outcome interdependence is the connection between personal benefits and costs tied to collective goal attainment, and task interdependence acknowledges interconnections between tasks that contribute to group performance, which leads to open and effective communication. Objectives in *League* include Towers, Dragon, Baron, Rift Herald, Blue Buff, Red Buff, Inhibitor or the enemy ADC (see Figure 2 in the preceding section). These all have very significant outcomes for an individual champion and for the team as a whole when they are secured efficiently. Usually, this consists of one or two champions working together directly to secure the objective while the rest of the team holds back the enemy, provides vision, applies pressure to other areas of the map, or provides healing/shields for the champions capturing the objective.

Throughout a match, players constantly need to strategize. They must think about farming and gaining experience, their individual item progression, and timers for objectives (Dragon, Baron, Buffs). Players must not only keep in mind their abilities and cooldowns, but also remember when the enemy's abilities are on cooldown, in order to coordinate an attack. The following excerpt from game 1 is a standard example of how players communicate with one another in order to coordinate:

> **C1:** Trundle is missing. I have TP and my Ult is up in forty.
>
> **C2**: Want to do rift, so we can push?
>
> **C4**: I'm going mid. You can do it. I'll get bot – there is a huge wave.

In the first line, we have C1 stating that the enemy champion in his lane was missing, that he had a teleport ability ready (which would allow him to teleport to a friendly location on the map), and that his ultimate ability would be ready in forty seconds. C2 suggested that the team's next action should be to take the Rift Herald, a powerful neutral monster, which, if slain, would provide a game-changing "buff" (e.g., enhancement) to the individual who secured it, and allow them to push down the lanes more easily. C4 made a calculated decision not to help his team take the objective. Instead, by going mid and then rotating bottom, he accomplished three things: (1) he continued to gather farm and experience that he would have missed out on attempting to take the Herald; (2) he kept the lanes pushed out, which not only gave his teammates a bigger cushion and provided more vision, but also made it more difficult for the enemy team to take objectives; and (3) since C4 was visible in the lane, the enemy team was less likely to think they were attempting to take a major objective.

In game 3, we observed an exchange across the team about securing a very important objective, Dragon. They were negotiating their positioning strategy for repelling the enemy team, and the need to establish vision and clear out the enemy vision wards, while constantly keeping track of the enemy Jungler, Hecarim. This was important because the Dragon is a neutral monster that can be secured with a summoner spell, such as Smite, which does a very large amount of "true damage" to a monster or minion. One strategy that is commonly used is "stealing" the dragon, where an enemy Jungler waits until the precise moment that Smite would kill the monster, and then sacrifices themselves to secure it for their team. In other words, a sole Jungler would receive credit for an enemy team's kill after they had expended significant effort to defeat it. This almost always leads to the enemy team attacking and killing the Jungler, who has left him/herself alone and vulnerable, but the objective being secured is more important to the team's overall success. Finally, as mentioned earlier, interdependence was shown throughout the match. Below we see instances where effectively managing one's individual role, balanced with the needs of the team, led to rapid instances of communication around securing objectives. While the communication may seem shallow, it is deeply infused with knowledge about the game as well as an understanding of how fellow teammates would react to these tense situations.

> **C5**: They have a pink ward in here and Hecarim is in there.
> **C4**: Dragons in twenty, we should move soon, swap down, swap down.
> **C5**: Yeah, Nautilus is staying here.
> **C1**: I have TP
> **C1**: I don't know where Hecarim was, he tele'd last time I did.
> **C2:** Dragon is in five.
> **C1**: I'll TP too.
> **C4**: Yeah, there is pink ward right here.
> **C4**: Watch this right here.
> **C5**: Nautilus is trying to TP.

C1: Nautilus is walking down.
C4: Uhh, you’re alone.
C1: Should I come?
C4: Yeah come, come, come, come. Brand’s really low.

Task cohesion, as mentioned previously, refers to the degree to which team members work together to solve an interrelated task or problem. For a high-stakes tournament, individuals will self-select a team to compete against others. In particular, at the Diamond level in *League*, players are competing against the top 2% of players in the world. It is necessary that the team members work together efficiently in order to win. We found that, in general, task cohesion was prevalent throughout the interactions of team members. A specific instance can be found when the team coordinated a team fight in game 2:

C3: I don’t think we can.
C4: . . . Ulti my shield.
C2 : I’m TPing.
C4: Team . . . TEAM!
C2: We can’t do that.
C4: TEAM!
C3: We were walking top.
C4: Yeah, we were walking. top probably shouldn’t of engaged there.
C1: Yeah my bad . . . . I just . . . I don’t know what to do.
C3: It doesn’t matter. We can win this. We just have to solve the game.
C4: Our late game is really good.
C2: Okay, let’s just split push and . . .
C3: I don’t think we can do it.
C2: They don’t have an ADC, so let’s just split push.
C5: That was a two for three, it wasn’t the end of the world.

It is evident that task cohesion does not always correspond to successful outcomes. Here, the team coordinated an attack against the enemy, but many of the members were out of position. C3 mentioned that they were walking top, while C4 was stuck fighting at a disadvantage near the bottom lane. Part of becoming a more cohesive team is anticipating these types of occurrences, and communicating movement effectively. Though communication broke down here, C3 and C5 provided encouragement (e.g., "just [having] to solve the game"; "it wasn't the end of the world"). This communication pattern helped re-establish psychological safety and group potency, while also acting as an anchor for continued task cohesion toward the greater overall goal of winning the game.

DISCUSSION AND CONCLUSION

Throughout this case study of one team's progression through a critical tournament match, we saw strong evidence that players were engaged in meaningful aspects of individual and collaborative learning processes important to our considerations of learning ecologies around informal game-based learning, such as improved decision-making, knowledge mastery, and reflection. Over the course of the match, we saw evidence of micro-level progressions in domain mastery, as evidenced through the framework of the proficiency-congruency dilemma. As expected, we observed the players' high investment in gaming, along with strong task cohesion. As a newer team, we also witnessed more discussion and negotiation, but also engagement in reflection through replay and abstracted replay, which improved the team's task and outcome interdependence over only three games. Specifically, we argue that even within the short temporal scale of a weekend tournament, we saw evidence of perceptual learning, or the improvement of learning over time through the refinement of individual and collective skills, as demonstrated by the team members' flexibility in adapting to increasingly complex challenges. While Team B seemed to display strong team proficiency and congruency, the progression through the three games further strengthened these qualities. Overall findings indicate that the team exhibited psychological safety and engaged in productive risk taking. These, in turn, worked in tandem with their group potency, which improved over time, and, according to theory, would also positively influence persistence and perseverance. We saw evidence of this happening, not only by continuing to persevere through the tournament, but in their dedication to improvement over the course of several matches. In fact, we would argue that this played a key role in Team B winning the tournament, particularly as the team least expected to do so.

Tournaments are not just temporal sites of performance mastery, individually or collaboratively. We argue here that they help highlight ways that teams have reflected upon and provide evidence of deliberate practice and situated learning. For instance, their continued references to metagame knowledge, and balancing of proficiency and congruency dynamics help to underscore their dedication to their craft. In this sense, they exhibited features of proficient players who have engaged in effortful practice and cognitive apprenticeship. In fact, almost all members of the team have reached the highest levels of gameplay in *League*, ranking amongst the top 2% of players worldwide. On the one hand, this case evidences applications of performance mastery utilizing practices we glean through interpretation; however, on the other hand, it is through high-stakes play that experts continue to hone their craft and apply transferable knowledge to novel challenges. While this case serves as just a snapshot of collaborative expertise, cultivated through situated learning and deliberate practice in a community of practice, it helps inform future directions in the study of how informal learning occurs in and through esports.

As mentioned previously, these findings are strongly connected to educational research on effective collaborative learning and a vast body of research on traditional athletic performance and improvement. By analyzing these psychological, social and performance-regulatory techniques as they are connected to informal learning, we can begin to understand the value of competitive esports as a legitimate interest-driven learning ecology, and increase general awareness of the development of individual and team-level expertise among players. However, of equal importance are the historic barriers to participation that women and girls, and non-dominant players of color face in gaming and related computing and STEM pipelines. This tournament, like most professional and collegiate esports competitions, typified a lack of gender and racial diversity: almost all players were white and Asian men. Despite the university organization's diverse membership, and its strong efforts to support women's participation, the vast majority of its competitive players reflected these demographics. As the legitimacy of esports increases at a societal level, we must more meaningfully attend to the variety of ways differential access may affect educational and professional opportunities for historically marginalized groups.

Future work will explore more longitudinal analyses of collegiate esports team members, moving from beginners, or peripheral members, to expert players and central members over longer periods of time, such as over the course of an academic year. We will also explore barriers to participation that inhibit psychological safety in this learning ecology, in order to better understand the continued lack of diverse gender and racial participation in high-stakes esports learning and performance, more generally.

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