Academic and Social-Emotional Learning in High School Esports

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Abstract: One decade ago, high school programs for organized, competitive video games, known as esports, were rare or non-existent. Now, there are multiple high school esports leagues expanding across North America, many claiming learning benefits for participation. The popularity of esports among high school students presents opportunities to foster Connected Learning environments. Little is empirically known, however, about actual outcomes of school-affiliated esports clubs, and reservations about the social and cultural influence of esports abound. In this quantified analysis of qualitative data, we examine the impact of a high school esports league on teens using national academic (NGSS) and social-emotional (CASEL) standards. Findings reveal important benefits in Science, Math, English language arts, social-emotional learning, and school affiliation. Surprisingly, the most dramatic benefits were social-emotional. Odds ratio analysis reveals the significant ($p<0.10$) role of mentorship (from teachers and coaches) and student leadership in such outcomes, supporting the Connected Learning model. Group comparison of outcomes for students in low-income versus high-income schools reveals significant differences ($p<0.10$) on 6 of 18 variables total, with students from low-income schools benefiting more from participation than students from high-income schools. This work provides early evidence of the positive academic and social-emotional outcomes esports may foster, for whom, and how.

Notice: This is a working draft of a paper still under review for publication. Please contact Dr. Constance Steinkuehler (const@uci.edu) or Esports Lab research manager Dr. Remy Cross (bcross@uci.edu) for permission to reference or cite. Any additional questions should be addressed to the above-named authors. The research presented in this paper was funded by a generous gift from the Samueli Foundation and the authors would like to thank the Foundation for their support.

Introduction

The Connected Learning model of learning (Ito et al., 2013) pays particular attention to informal contexts that are “socially embedded, interest-driven, and oriented toward educational, economic, or political opportunity” (p. 6). It emphasizes the efficacy of (a) student-led activities and interests and (b) positive relationships with peers and mentors in the development of academic and social-emotional learning. Given students’ interest in video games, researchers have explored the kinds of learning that games can encourage in and out of the classroom, including scientific reasoning (Clark, Nelson, Sengupta, & D’Angelo, 2009; Authors, 2008b; Wauck, Mekler, & Fu, 2019), literacy (Gee, 2003; Leander & Lovvorn, 2006; Authors, 2008a), and technology expertise (Hayes, 2008). That work, however, has yet to examine organized, competitive video games, known as esports, and the school-affiliated esports clubs growing in popularity in North America. Esports offer a new area of interest in which scientists and educators might study and foster the student-led atmosphere and mentoring relationships that characterize Connected Learning. Still, reservations about the cultural, social, and emotional environment around esports are well-founded. Gender diversity at the highest levels of competitive play in the most watched games is non-existent (Seiner, 2019). Professional streamers keep using derogatory slurs (e.g. “YouTube star”, 2017; Gilbert, 2018; Thier, 2019). Some of those who watch streamers even use emotes in derogatory ways so often that certain emotes are banned on a number of channels (Grayson, 2019). It is for precisely these reasons, though, that esports make an exciting space to introduce mentors and encourage interest-driven learning to test the Connected Learning model.

Since 2017, multiple leagues originally focused on organizing local high school esports have expanded their focus to national level growth (Authors, in review). This recent expansion of high school esports programs is predicated on arguments that such programs have the potential to benefit participating students through promoting engagement in school and creating an environment in which students learn scholastic, professional, and social skills (Freeman & Wohn, 2017a). In a landscape analysis of all 11 high school esports programs across the United States, Authors (in review) found that every program studied framed their high school esports program as providing positive academic and social-emotional benefits for students who participate, including increased engagement, professional skill development, and social and emotional learning. To date, however, such claims have not been tested empirically.

Studies of Connected Learning have been conducted in broader video game communities. For example, in a study of StarCraft II (Blizzard Entertainment, 2010) communities, Kow, Young, and Salen-Tekinbaş (2014) detail the role of players’ community leadership in lowering barriers to knowledge and the necessity of “families and educators invested in creating and supporting daily structures of participation of young people” (Kow, Young, and Salen-Tekinbaş, p. 44). The goal of this research, though, is to empirically examine the existing and potential impacts of student participation in high school esports clubs specifically. This work builds on a qualitative investigation of the North America Scholastic Esports Federation (NASEF) (Authors, 2019a) that was focused on identifying organic learning opportunities that arose during league play that might then become the basis of subsequent enrichment activities. In this first study, Authors (2019a) conducted observations of and focus groups with student players, involved teachers, and team coaches, in addition to interviewing parents of participating students. From those observations, focus groups and interviews, they highlight aspects of the program’s design to be interrogated further. They also identified “critical analysis, communication, research skills, and social-emotional learning” (Authors, 2019a) as potential areas for this kind of program to support learning. In this subsequent study, we interrogate these qualitative observations through the development and application of a structured coding scheme and statistical analysis of the patterns found. These analyses test whether Authors’ (2019a) findings were indeed systematic patterns in the data.

The research question driving this investigation is, how does participation in an after school esports club align with academic and social-emotional learning standards? Using qualitative interview data from 55 esport club participants and 15 esports staff (selected from 6 local schools selected for maximum variation in terms of income and ethnicity), we conducted a quantitative analysis of qualitative data using a structured coding scheme based on select national academic (NGSS) (National Science Teaching Association, 2014) and social-emotional learning standards (CASEL) (Collaborative for Academic, Social, and Emotional Learning, 2019) and then statistically testing the relationships among variables to discern (1) what students participating in esports learned from the program, (2) what moderating variables shape those learning outcomes, and (3) whether the outcomes were equitable.

The results of this investigation provide evidence that high school esports programs can indeed have positive impacts on academic and social-emotional outcomes as predicted based on US program rhetoric. All 18 codes representing national learning standards used across four domains (science, math, English language arts or ELA, and social-emotional learning or SEL) were present in some form in the data. SEL was the most frequently occurring learning indicator (n=797) followed by math (n=294), English language arts (n=240), and science (n=90). Odds ratio analysis revealed that staff mentorship and student leadership opportunities increased the odds of learning occurring. These findings suggest that the positive relationships formed with both adults and peers (cf. Haudenhuyse, Theeboom, & Coalter, 2012; Taliaferro et al., 2011) as a result of the league were important mediating variables for the outcomes found: Mentorship was a significant ($p<0.10$) mediating variable for seven of the eighteen learning outcomes, while student leadership significantly ($p<0.10$) mediated four learning outcomes. Group comparison of outcomes for students in low-income versus high-income schools revealed significant differences ($p<0.10$) on 6 of the total 18 variables, with students from low-income schools benefiting more from participation in the esports program than students from high-income schools.

This work contributes to our understanding of the substance of structured esports participation. It provides early evidence of which positive academic and social-emotional outcomes esports may foster, for whom, and how.

Related Work

In his analysis of the business of esports, Scholz (2019) attributes the recent growth and interest in esports to five main factors: their international and digital reach, the youth of the esports fan base, the still-emerging nature of the industry, esports' differentiation from traditional sports, and the self-regulation that has developed in the esports ecosystem over the past 60 years. The academic study of esports has also developed rapidly over the last decade (Authors, 2019b), and at the confluence of research and practice are esports programs in schools. There are promising arguments for scholastic and extracurricular esports programs, like NASEF, leveraging students' interests to help them engage with their schools, communities, peers, and classroom subjects (Authors, in review). Evidence for those benefits is lacking, however. The present study contributes data to this conversation.

Preceded by Leavitt, Keegan, and Clark's (2016) research on nonverbal communication in competitive games, Freeman and Wohn (2017a) contribute to the current conversation around esports by providing definitions of the phenomena seated in player perception. Players in Freeman and Wohn's study reposition our understanding of esports, focusing on competition, systems of goals and rules, professional scenes, spectatorship, intellectual and motor skills, governing bodies, and human competitors. In short, esports contain multimodal experiences beyond that of computer-mediated competition alone. Freeman and Wohn foster further discussion with empirical and qualitative research projects (Freeman & Wohn, 2017b; Freeman & Wohn, 2018). The former detailing the in- and out-of-game emotional support and esteem between players, most of whom begin as strangers, and the latter pulling from Leavitt, Keegan, and Clark's (2016) work to highlight the coordination of team activity and communication between teammates. In recent history, researchers have also investigated toxic behavior in esports and competitive gaming communities. Some have linked patterns of communication in game to performance and toxicity using in game reporting metrics (Neto, Yokoyama, & Becker, 2017). Others have sought to find appropriate definitions for the behaviors associated with toxicity and a more detailed account of how players cope with these types of behaviors through university-level esports clubs (Adinolf & Turkay, 2018).

Games, Sports, and Learning

While there is little data on the benefits of esports leagues specifically, researchers have examined the kinds of learning that can happen in and around video games. From fostering scientific reasoning (Clark et al., 2009; Authors, 2008b; Wauck, Mekler, & Fu, 2019) to improving literacy (Gee, 2003; Leander & Lovvorn, 2006; Authors, 2008a) to strong associations with technology expertise (Hayes, 2008), playing video games and participating in the communities around them has been found to promote or correlate with certain kinds of learning. Clark, Nelson, Sengupta, and D'Angelo (2009) highlight science learning in particular. Their argument is explicitly not that games are superior learning tools to textbooks. Rather Clark et al. (2009) walk through how games can be a part of an educational approach that integrates "people's tacit spontaneous concepts with instructed concepts, thus preparing people for future learning through a flexible and powerful conceptual foundation of conceptual understanding and skills" (p. 3). In other words, while textbooks lend themselves to efficiently and clearly presenting facts and theories for rote learning, games can build players' intuitive understanding. Authors (2008b) offer empirical evidence for the development of scientific habits of mind in *World of Warcraft*. The forum discussions they studied contained systems- and model-based reasoning, social knowledge construction, and an understanding of knowledge to be "an open-ended process of evaluation and argument" (Authors, 2008b). These are all examples of the tacit learning that Clark et al. (2009) say games are capable of fostering.

There is also evidence for benefits of participation in school sports. Those benefits have been found to include associations with higher persistence (Astin, 1984) and higher GPA (Fox, Barr-Anderson, Neumark-Sztainer, & Wall, 2010). The "especially pronounced, positive effect" (p. 523) of sports on persistence and retention that Astin (1984) reported supports the argument that getting students involved and engaged with their schooling can happen outside the classroom. Astin's data, though, came from a longitudinal study of college students and dropouts. Fox et al. (2010) more recently collected data from middle and high school students. They found that participation in the school sports team was associated with higher GPAs. That relationship was independent of the amount of physical activity for high school boys, implying that participation in a school team may encourage academic success regardless of the exercise involved.

Like school-sponsored sports teams, esports clubs have seen potential to serve as active and connected learning spaces. Research in game-based teaching and the social and motivational inclusive potential of commercial games has shown positive effects in student wellbeing and a reduction of external regulation (Lieberoth & Hanghøj, 2017). There is also evidence, though, that the impact of games as an intervention is dependent on individual students' social and academic needs (Hanghøj, Lieberoth, & Misfeldt, 2018). Other research efforts (e.g. Lieberoth, Fiskaali, & Spindler, 2018) are also designed "with the understanding that youth learn and develop an interest over time, across settings, and in partnership with others" (Authors, 2019c).

Ito et al. (2013) note that instead of being innate, interests "are discovered and cultivated within particular social and cultural contexts. Social relationships and institutional supports for interests are diverse and often involve adults and can bridge contexts of home, community, and commercial culture" (Ito et al., 2013). Each of these studies, as well as other research at the intersection of esports and education have allowed student-subjects to pursue their interests in a variety of aspects of competitive games, communities, and affinity groups. Through structured and unstructured mentorship and assistance they have also linked these activities to pedagogy. This reflects Ito et al.'s (2013) definition of Connected Learning. Like any other context, esports can "serve as a rich learning environment as well as a boundary object that motivates the shared activity between children, parents, experts, and community members" (Vartiainen et al., 2018).

Esports clubs are attractive to students for reasons beyond the desire to play and compete. From designing to organizing to commentating (Kempe-Cook, Sher, & Su, 2019), esports clubs can give students a space to practice skills in a context that interests them. Author (2018) identify "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" (Authors, 2018). The esports ecosystem supports competition, participatory community, and social interactions in pursuit of common endeavors.

This is made explicit in Authors' (2019a) identification of unanticipated learning possibilities through a secondary school competitive esports league. Their qualitative work revealed programmatic pain points such as difficulties with program inception, scheduling, and communications, as well as inequities across equipment, access, and student proficiency. However, other key findings included organic efforts from educators and students alike, to develop different aspects of knowledge, such as website production, film editing, and critical team analysis. The program also saw notable increases in in-game proactive communications, such as "shotcalling and anticipatory analysis, [and] support/morale statements" (Authors, 2019a), and all groups of participants reported improvements in social-emotional learning, specifically self-management, social awareness, relationship skills, and responsible decision making.

Quantifying Qualitative Data

Context of Study

This investigation into the academic and social-emotional learning outcomes of esports was conducted within the context of the largest high school esports program to date, the North America Scholastic Esports Federation (NASEF). NASEF is a nationally organized after-school esports program that currently spans more than 400 schools and organizations across 36 states in the US and 3 provinces in Canada (North America Scholastic Esports Federation, 2019). NASEF was selected as a site for investigation given its stated goal of using esports as a means to engage students in topic-relevant academic and prosocial learning. The data examined for this study, however, were collected during NASEF's first year of competition when nothing more than the competitive league structure was implemented, before it expanded beyond a single county, before classroom curricula were developed and approved, and before a club structure was developed to overtly foster student intellectual and social development. Thus, the findings should generalize to high school esports programs generally.

At the time these data were collected, the NASEF league consisted of a pilot network of school-affiliated after-school clubs with teacher-organizers, coaches, and student-players. At each implementation site, teachers played the role of general managers (GMs) to help organize practices and matches and virtual coaches, provided by Connected Camps (2019), prepared teams for competition. *League of Legends* (LoL) (Riot Games, 2009) was the game title selected for competition. Swiss-style tournament brackets were played over eight weeks, culminating in a full day of matches that were streamed live on Twitch from a local professional community esports arena. The championship event was organized and emceed by a combination of local university undergraduates and participating high school students.

Participants

The data used for this analysis were originally collected as part of a qualitative analysis of student activities in the league (Authors, 2019a). Six local school sites were selected for maximum variation in school-wide geographic, income, and racial/ethnic demographics, prioritizing variation in percentage of students receiving free or reduced-cost lunch. Percentages of students receiving free or reduced-cost lunch across these sites range from 10% to 73%, with a mean of 35%. From those six sites, 55 students participated in five student focus groups, 10 GMs participated in six GM focus groups, and 5 coaches participated in three coach focus groups. Data on the income levels of individual students' families were not collected.

Procedure

Data were collected through semi-structured focus group interviews, conducted in-person or online via a private Discord server, immediately after the first league season championship event. Two researchers conducted the interviews using a semi-structured protocol that standardized the topics covered but allowed for conversational variation on the actual form of questions used. Interview topics for both student and staff, interviewed separately, were: attitudes toward the league; changes to gameplay and teamsmanship; impact on schoolwork, attitudes toward school, and relationships; and what was learned from participation.

Data Corpus

The resulting interview data corpus was transcribed, cleaned, and then reduced by removing staff discussion that was not related to student activities (specifically, discussion of scheduling, league logistics, and administration). Data were segmented into units of analysis representing turns of talk with one unit equaling one speaker turn. Table 1 details the resulting corpus.

Table 1. Data Corpus.

Participant Role	Number of Turns of Talk	Number of Words
Students	449	45999
Coaches	24	42979
General Managers	53	48118
Total	526	137096

Data Analysis

A coding scheme (Table 2) based on the work of Stage, Asturias, Cheuk, Daro, and Hampton (2013) was developed to capture key interconnected science, math, and English language arts (ELA) standards developed by the National Science Teachers Association (figure 1) (Stage et al., 2013). We then supplemented these academic standards with codes representing the social-emotional learning (SEL) standards recommended by the Collaborative for Academic, Social, and Emotional Learning (CASEL, 2019) and three additional codes based on the Connected Learning (CL) model (Ito et al., 2013): (1) *school affiliation*, defined as students' increased positive attachment and/or affinity toward their school; (2) *mentorshi*p, defined as the positive modeling and/or enculturation of students by a teacher GM, a coach, or another student; and (3) *student leadership*, defined as students decision-making and/or community organizing to positively affect the team or club.

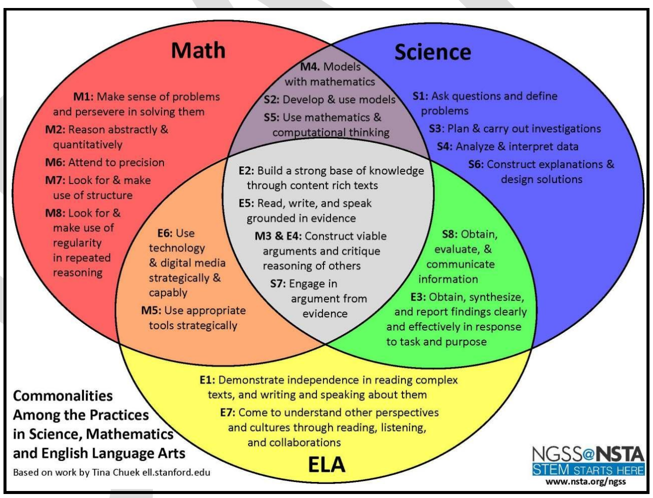

Figure 1. Academic content standards (Stage et al., 2013).

Four researchers coded the entire data corpus with 4-way interrater reliability. To calculate IRR, 10% of the corpus was selected at random, by assigning a randomly generated number to each turn of talk and coded by the four researchers independently. Agreement was defined as a 4-way match on each turn of talk (the unit of analysis used). Any discrepancy across the 4 counted as a disagreement, yielding an interrater reliability of 92.31%. Here, each code represents an indicator of the specific forms of learning that students, GMs, and coaches reported (manifest content) or alluded to (latent content) in reference to esports participation. Codes are not mutually exclusive (each turn of talk could have multiple codes applied), which allowed us to test for significant relationships among learning outcome codes (science, math, English language arts, social-emotional skills) and possible mediating variable codes (mentorship, student leadership, school income).

Next, mediating and standards' codes were assessed on a one-to-one basis to see if they were dependent. This was done by tabulating the codes' presence in a turn of talk with 2x2 contingency tables. Typically, Pearson's Chi Square or Fisher's Exact are used to assess independence. However, the data did not meet the requirements of fixed margins for Fisher's Exact or the expected cell counts for Pearson's Chi Square. Therefore, Boschloo's Exact Test (Boschloo, 1970), with a null hypothesis of independence between codes, was chosen in their stead. Odds Ratios and their 95% confidence intervals were then calculated to determine the strength and direction of any possible dependence. Odds ratios were calculated to measure the effect of a mediating variable on a standard's code appearing in talk and should be interpreted as the change in odds of a standard appearing if a mediating variable was present. Odds-Ratios with values less than one indicated a drop in odds of a standard's appearance, while values greater than one represented the opposite.

Table 2. Coding Scheme (with source in parentheses)

Science
Ask questions & define problems (NGSS S1)
Plan & carry out investigations (NGSS S3)
Analyze & interpret data (NGSS S4)
Scientific explanations (NGSS S6)
Design solutions (NGSS S6)
Math
Reason quantitatively (NGSS M2)
Attend to structure (NGSS M7)
Attend to regularity (NGSS M8)
Problem-solving (NGSS M1/S5)
English Language Arts
Communicate info/findings (NGSS E3/S8)
Use evidence (NGSS E5)
Construct/critique argument (NGSS E4/M3)
Social-Emotional Learning
Self-awareness (CASEL)
Self-management (CASEL)
Social awareness (CASEL)
Relationship skills (CASEL)
Responsible decision-making (CASEL)
Affiliation (CL)
Mediating Variables
Mentorship (CL)
Student Leadership (CL)

To test for differences by school income level, we categorized each of the six school sites from which data were collected by income level based on their percentage of students receiving free or reduced-cost lunch. Schools with less than 40% free or reduced-cost lunch were categorized as high income and schools with 40% or higher were categorized as low income following Title 1 definitions (U.S. Department of Education, 2018). Using these data, we then categorized student and staff interviews by the income level of their school and compared the overall percentage of learning indicators in talk from high income schools to talk from low income schools. Participants were then grouped by school income and we again used Boschloo's (1970) Exact test to assess whether each standard's odds of appearing in a turn of talk depended on the income level of the school the participant attends or works at. Odds Ratios were again calculated to determine the strength and direction of dependence.

Results

Overall Student Outcomes

The highest individual outcome variables are Social-Awareness (n=191), Relationship Skills (n=163), and Self-Awareness (n=153). The lowest two counts fell under Science: Scientific Explanations & Design Solutions (n=3) and Plan & Carry Out Investigations (n=5).

Mentorship & Student Leadership

In order to better understand the features of the NASEF league that might contribute to its impact based on the Connected Learning model (Ito et al., 2013), we then tested the relationship of Mentorship and Student Leadership to student outcomes. Note: codes “Plan and Carry Out Investigations” and “Scientific Explanations & Design Solutions” did not meet the sample size requirement for statistical analysis and have been omitted.

Table 3. Learning standards’ dependence on Mentorship & Student Leadership

	Mentorship			Student Leadership		
Code	**Boschloo's**	**OR**	**95% CI**	**Boschloo's**	**OR**	**95% CI**
Science: Ask Questions & Define Problems	~0*	4.60	2.36 - 8.95	0.4378	0.57	0.17 - 1.9
Science: Analyze & Interpret Data	0.0731+	2.34	0.95 - 5.78	0.7278	1.13	0.33 - 3.9
Math: Problem-Solving	0.0334*	2.43	1.08 - 5.46	0.0003*	4.75	2.17 - 10.4
Math: Reason Quantitatively	0.7007	0.42	0.05 - 3.24	0.211	2.07	0.57 - 7.56
Math: Attend to Structure	0.2211	1.48	0.81 - 2.72	0.1767	1.56	0.8 - 3.04
Math: Attend to Regularity	1	0.96	0.47 - 1.97	0.0117*	0.20	0.05 - 0.84
Math: Appropriate (Math/Digital) Tool Use	0.1508	1.79	0.82 - 3.92	1	0.86	0.3 - 2.51
ELA: Communicate Info/Findings	0.013*	2.37	1.24 - 4.53	0.2556	1.57	0.73 - 3.39
ELA: Construct/Critique argument	1	0.95	0.48 - 1.89	0.5508	0.74	0.32 - 1.69
ELA: Use Evidence	0.0334*	2.16	1.09 - 4.27	0.0583+	2.06	0.97 - 4.36
SEL: Self-Awareness	0.7603	1.09	0.63 - 1.9	0.2586	0.66	0.33 - 1.31
SEL: Self-Management	0.7374	1.09	0.6 - 1.98	0.5809	1.16	0.6 - 2.24
SEL: Social Awareness	0.0548+	1.67	1.01 - 2.76	0.8734	1.07	0.6 - 1.92
SEL: Relationship Skills	0.1187	1.50	0.89 - 2.52	0.0001*	3.07	1.76 - 5.35
SEL: Responsible Decision-Making	0.0761+	1.73	0.94 - 3.2	0.1632	1.62	0.81 - 3.22
SEL: Affiliation	0.8138	1.05	0.47 - 2.32	0.7936	0.81	0.31 - 2.12

* $p < 0.05$
+ $p < 0.10$

As indicated in Table 3, Mentorship yielded four significant results across Science, Math, and ELA domains. ”Ask Questions & Define Problems” had the largest Odds Ratio (4.60), with a confidence interval well above 1. It is followed by “Problem Solving” (2.43), “Communicate Info/Findings” (2.37), and finally “Use Evidence” (2.16). Interesting, but not significant results include “Analyze and Interpret Data” (2.34) and “Social Awareness” (1.67). While their p values are not considered significant, they are small. Additionally, their confidence intervals do not straddle 1 and are skewed towards higher values.

Student Leadership had three significant results within the Math and SEL domains. “Problem-Solving” had the highest Odds Ratio (4.75), followed by “Relationship Skills” (3.07). Both indicate positive relationships with Student Leadership. However, “Attend to Regularity” (0.20), while significant, yielded an odds ratio below one, suggesting the opposite. Like Mentorship, Student Leadership included one interesting result that is not significant: “Use Evidence” has an Odds Ratio greater than one (2.06) and a confidence interval that is skewed above one, along with a smaller p value.

Equity

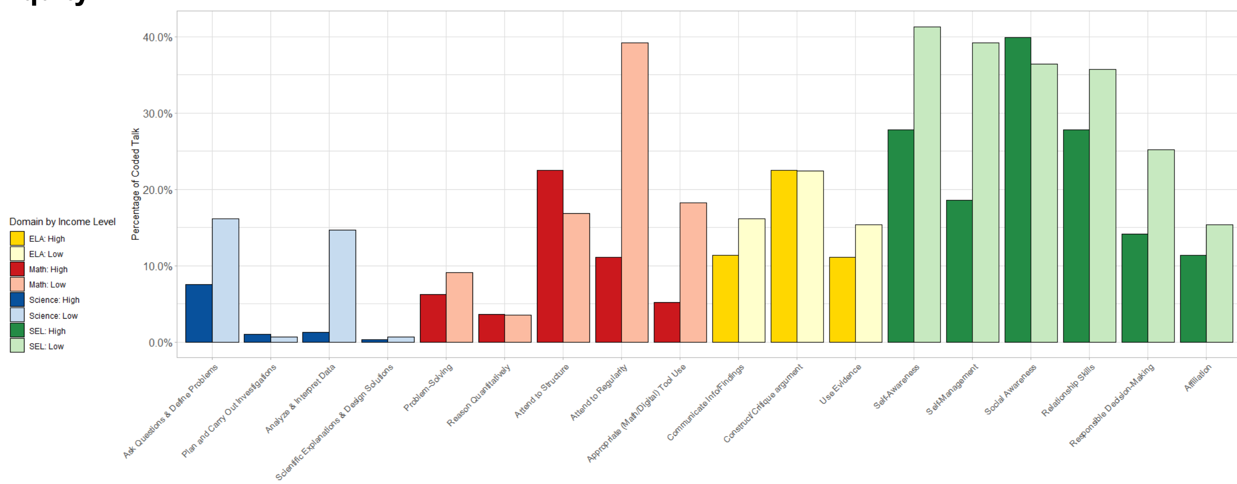

Figure 2. Student learning indicators across four domains (science, math, English language arts, social-emotional learning) by school income level.

To investigate whether outcomes were the same for students in low and high income schools, we then compared learning outcomes for low-income versus high-income schools. Figure 2 illustrates the percentage of talk coded by our learning indicators for each school income level and Table 4 lists Odds Ratios and other analyses. Odds Ratios are interpreted as one shifts from high income to low income. The science standard of “Analyzing & Interpreting Data” showed the greatest gain for low income students over high income students (odds-ratio = 11.61), followed by “Appropriate (Math/Digital) Tool Use” in Math (odds-ratio = 3.34), “Self-Management” in SEL (odds-ratio = 3.20), and “Responsible Decision-Making” in ELA.

Table 4. Dependence of learning standards on school income level

Code	Boschloo’s	OR	95% CI
Science: Ask Questions & Define Problems	0.447	1.33	0.66 - 2.67
Science: Analyze & Interpret Data	~0	11.61	3.87 - 34.82
Math: Problem-Solving	0.3922	1.42	0.65 - 3.12
Math: Reason Quantitatively	0.7614	1.19	0.39 - 3.62
Math: Attend to Structure	0.1082	0.64	0.37 - 1.11
Math: Attend to Regularity	0.0009*	2.5	1.48 - 4.23
Math: Appropriate (Math/Digital) Tool Use	0.0006*	3.34	1.67 - 6.7
ELA: Communicate Info/Findings	0.3192	1.36	0.74 - 2.5
ELA: Construct/Critique argument	0.8798	0.94	0.55 - 1.61
ELA: Use Evidence	0.2244	1.49	0.79 - 2.8
SEL: Self-Awareness	0.0062*	1.82	1.18 - 2.8
SEL: Self-Management	<0.0001*	3.2	2 - 5.12
SEL: Social Awareness	0.6532	0.89	0.58 - 1.36
SEL: Relationship Skills	0.1287	1.41	0.91 - 2.19
SEL: Responsible Decision-Making	0.0003*	2.76	1.61 - 4.74
SEL: Affiliation	0.6009	0.81	0.4 - 1.63

Discussion

Quantifying qualitative data allows statistical testing of patterns and relationships between variables. The strength and import of these findings, however, are contingent on the quality of the data source, the relevance of the coding scheme applied, and the statistical procedures used. The coding scheme used in this study represents a detailed set of specific learning goals across domains in which high school esports aspire to effect change. The patterns found as a result of this analysis are in keeping with a previous qualitative evaluation (Authors, 2019a), while providing a more detailed window into the natural outcomes of students' participation in a school-affiliated high school esports league.

Science & Math

First, Science and Math appear to be a natural part of students' NASEF activities, with notable emphasis on attending to structure and regularity (M7 and M8), appropriate tool use (M5), asking questions and defining problems (S1), and analyzing and interpreting data (S4). Mathematizing esports content seems more naturally aligned with competitive play, with both game and league structures providing a rich context for quantitative and analytical thinking. Particularly fruitful were activities in which students' analyzed data available on their own performance (35% of such cases), the performance of their team (50%), or the performance of their opponent (17%). The following interview excerpt illustrates:

> I'm a lot more careful when I do go into a game, even before the game even starts, like in champ[ion] select. I check to see how we can really make plays together as a team. If I'm last pick I'll see – okay, so this person's heavily on AD [attack damage] or this person I can really synergize well with… it's just team composition is huge and small things in game...can mean the difference between losing a game or winning a game and just very small, incremental things that really heavily depend on whether or not you're successful in *League of Legends*. (School 3, Student 1)

Scientific forms of reasoning, by way of contrast, appear to be more potential than actualized outcomes, with greater evidence of the first phases of scientific inquiry – like asking questions, defining problems (S1), and analyzing data made available via the game or league interface (S4) – than the latter half of the scientific process – carrying out investigations (S3), developing scientific explanations, and designing solutions (S6).

English Language Arts

Communication and argumentation were also core parts of students' naturally occurring activities during league participation. Students engaged in both expository and persuasive oral and written texts as a natural part of their preparation for competitive play. In more than half of such arguments presented, students used evidence as a means to support their claims. Communication skills were improved not only from face-to-face after-school interactions but also from their in-game interactions as well. The following interview with a teacher GM illustrates:

> I don't have any of my team as students, but I did notice that their levels of communication did improve as the coaching sessions went on, and in terms of their game playing and their skills, definitely there was a huge improvement… I think they're becoming more thoughtful in what they're saying, in what they need to say and what they need not to say. (School 3, GM 1)

Social Emotional Learning

Perhaps our most surprising finding, however, is the striking emphasis on social emotional learning gains across the interviews. Both students and staff spoke at length about the ways in which the league was transformative in terms of both self-awareness and self-management, on the one hand, and social-awareness and relationships skills, on the other. Students frequently told stories about transformation in their understanding and skills of emotional regulation, social acumen and sensitivity, and the ability to regulate what many refer to as "tilt" – strong emotional responses during gameplay that degrades decision-making and teamwork. For example, as one student commented,

> I get tilted very easily, and whenever I play with them, I would start getting upset, and they would start joking, and it would take me *off* tilt, and then I would sit down and focus and be like, okay, I know what I've been doing wrong. I know how to improve it for the next games. So, I haven't been getting as tilted as often, because I have gotten better to where if someone does do really horrible, I don't care. I just focus on myself playing. (School 4, Student 3)

These strong patterns of increased social and emotional well-being are remarkable given the broader context of esports and internet communication more generally, suggesting the potential of organized, school-sanctioned youth esports to combat toxicity online. Students also remarked on the role the league had in increasing their affiliation with school. By acknowledging students' interests and making a space for their game-related accomplishments, students came to feel more meaningfully connected to both the institution of schooling and the adults participating in it. As another student commented:

> I was really excited to hear about it [NASEF] too because I have been playing this game since 2012. I thought, yeah, this is something I want to do. This is what I've always wanted in school. I've always avoided actual sports and everything because I hated the crowd. This is where I felt like I could truly fit in. (School 1, Student 3)

Equity

Students from lower-income schools showed greater gains than students from higher-income schools (figure 2), contrary to initial concerns about the equity of esports based programming for high schoolers based on prior research. Authors' (2019a) initial qualitative evaluation of the NASEF league found barriers to participation for some students based on limited access to gaming computers and lack of representation in certain game communities. While the increased learning outcomes for students from low income schools allow us to infer that economic inequities do not interfere with interest-driven learning in this context, they do not assess these other forms of equity that create barriers to entry for many. Such findings are therefore encouraging but require further investigation to assess differences based on gender, ethnicity, sexual orientation, and level of gameplay skill.

Mentorship & Student Leadership

Mentorship and student leadership both seem to mediate the relationship between league participation and many of the benefits found in this study. Teacher GMs and coaches appear to play a key role in modeling behavior and fostering environments in which students learned to focus on improving their social, communication, and analytical skills. Having experts model best practices for team play and success, such as post-game reflections, gave students tangible actions to take before, during, and after each game. Over the course of the eight-week regular season, both students and staff reported changes in the way students spoke to each other. The kinds of information shared, the tone of interactions, and the usefulness of their utterances grew more self-aware and task-oriented (Authors, 2019a). The mentorship and opportunities for student leadership that coaches and teachers provided appear to play a vital role in enabling the learning outcomes discussed in this work.

We want to emphasize the influence of mentors in the club space. In these results and those of Authors (2019a), the presence of near-peer coaches helped encourage self-reflection and positive communication skills. King notes that "without this direct scaffolding, students rarely recognized the connections between their game-based learning and other efficacious practices" (King, 2015), indicating that this self-reflection was what led to improvements. Adopting this mindset, student learning can be bolstered by the presence of peers and mentors, not because of the esports context itself. While esports can certainly be a rich context for learning opportunities, we infer that students are benefiting more because of the relationships they build.

Future Work

As high school esports gains broad popularity, so too do our opportunities for authentically engaging young people in crucial academic and social-emotional skills by connecting students' interests to core ideas and practices valued beyond the game. Since these data were collected in the first league season and based on the initial qualitative evaluation of the program (Authors, 2019a), NASEF has evolved their after-school programming from a mentored competitive league to a full-service after-school enriched esports club structure emphasizing not only in-game competition but also out-of-game professional roles including strategists, content creators, organizers, and entrepreneurs (Authors, 2018). Digital toolkits, content curricula, and weekend workshops are now available to supplement and enrich student activity. Most recently, a four-year high school English Language Arts curriculum, based on this preliminary research and developed by local master teachers, was approved by the State of California and will be made available for schools Fall 2019. These design efforts build on the intellectual and social-emotional skills and opportunities that naturally arise as part of participation that are detailed herein. The next important step in this line of inquiry is to assess the impact of high school esports when enriched by carefully designed and standards aligned materials. The research question driving this next phase of investigation will be, how does participation in an *enriched* esports club foster academic and social-emotional skills?

Conclusion

Our findings provide preliminary support for the popular claim made by high school esports organizers in the US: for students passionate about esports, school-affiliated competitive gaming can foster environments for interest-driven learning.

Most noteworthy are the significant positive social-emotional learning gains reported by both students and staff. Both qualitative (Authors, 2019a) and quantitative findings highlight the ways in which the esports league fostered self- and social-awareness and regulatory skills. Of all our results, we find these perhaps the most compelling. For many teens, the competitive frame that esports provides around video game play is the first real experience they have had of authentic, extended "in situ" mentorship in how to behave online. Enriching esports programming here may well be one powerful means for re-humanizing online gaming generally, and such re-humanizing is sorely needed.

Contrary to initial concerns about equity by income, overall positive outcomes tend to favor lower-income schools rather than higher-income schools. This finding is somewhat counter-intuitive yet consistent with the general pattern of findings across games for learning research: Video games, when integrated into formal or informal educational environments, tend to show the greatest gains among students who are otherwise most at risk (Squire, 2011; Authors, 2009; Young et al., 2012).

Moreover, these results suggest not only *that* positive academic and social-emotional outcomes are possible from esports programming but also *how* they are made possible – through relationships with adults and near-peers and opportunities for students themselves to lead (Ito et al., 2013). Thus, this study might in part be considered a validation of the Connected Learning model itself, demonstrating that, indeed, programming based on student interests, tied to academic and social opportunities, and *enabled by positive relationships* is a potent vehicle for student learning. In this context, esports becomes a veritable trojan horse for academic and pro-social/emotional development.

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