18. Academic and Social-Emotional Learning in High School Esports

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Abstract: Multiple high school esports leagues are expanding across North America, 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. We examine the impact of a high school esports league on teens using national academic and social-emotional standards. Findings reveal important benefits in science, math, English language arts, social-emotional learning, and school affiliation. The most dramatic benefits were social-emotional. Odds-ratio analysis reveals the significant ($p < 0.10$) role of mentorship 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.

Introduction

Recent expansion of high school esports programs is predicated on arguments that such programs can benefit participating students by promoting engagement in school and creating an environment in which students learn scholastic, professional, and social skills. To date, however, such claims have not been tested empirically. Studies of connected learning (CL; Ito et al., 2013) investigating video game communities have emphasized the role of players' community leadership and the necessity of "families and educators invested in creating and supporting daily structures of participation of young people" (Kow, Young, & Salen-Tekinbaş, 2014, 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; Cho, Tsaasan, & Steinkuehler, 2019) that identified organic learning opportunities that arose during league play. We interrogate these qualitative observations through the application of a structured coding scheme and statistical analysis of the patterns found.

How does participation in an afterschool esports club align with academic and social-emotional learning (SEL) standards? We conducted a quantitative analysis of qualitative interview 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) to discern (a) what students participating in esports learned from the program, (b) what moderating variables shape those learning outcomes, and (c) 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 U.S. program rhetoric. 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

The academic study of esports has developed rapidly during the last decade (Reitman, Anderson-Coto, Wu, Lee, & Steinkuehler, 2019), and at the confluence of research and practice are esports programs in schools. There are promising arguments for scholastic and extracurricular esports programs, such as NASEF, leveraging students' interests to help them engage with their schools, communities, peers, and classroom subjects. Evidence for those benefits is lacking, however. The present study contributes data to this conversation.

Games 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, Nelson, Sengupta, & D'Angelo, 2009; Steinkuehler & Duncan, 2008) to improving literacy (Gee, 2003) to strong associations with technology expertise (Hayes, 2008), playing video games and participating in the communities around them correlates with certain kinds of learning. Clark et al. (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 foundation of conceptual understanding and skills" (p. 3). The forum discussions Steinkuehler and Duncan (2008) 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." These are all examples of the tacit learning that Clark et al. (2009) say games are capable of fostering.

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. Anderson et al. (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" (para. 1). The esports ecosystem supports competition, participatory community, and social interactions in pursuit of common endeavors.

Quantifying Qualitative Data

Context of Study

This investigation was conducted during the North America Scholastic Esports Federation's (NASEF) first year of competition. NASEF consisted of a competitive league in one county with a network of school-affiliated clubs with teacher-organizers (GMs), coaches—provided by Connected Camps (2019), —and student-players. *League of Legends* (*LoL*; Riot Games, 2009) was the game selected for competition. Swiss-style tournament brackets were played over eight weeks, culminating in a full day of live-streamed matches. The championship event was emceed by a combination of local university undergraduates and participating high school students.

Participants

Six local school sites were selected for maximum variation in schoolwide 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 five coaches participated in three coach focus groups.

Procedure

Data were collected through semistructured focus-group interviews, conducted in-person or online via a private Discord server. Two researchers conducted the interviews using a protocol that standardized the topics covered but allowed for conversational variation on the actual form of questions used. Interview topics for both students 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 and cleaned by removing staff discussion that was not related to student activities. Data were segmented into turns of talk with one unit of analysis equaling one speaker turn. Table 1 details the resulting corpus.

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

Table 1. Data corpus.

Data Analysis

A coding scheme (see 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 (see Figure 1; Stage et al., 2013). We then supplemented these academic standards with codes representing the SEL standards recommended by the Collaborative for Academic, Social, and Emotional Learning (CASEL, 2019) and three additional codes based on the CL model (Ito et al., 2013): (a) *school affiliation*, defined as students' increased positive attachment or affinity toward their school; (b) *mentorship*, defined as the positive modeling or enculturation of students by a teacher GM, a coach, or another student; and (c) *student leadership*, defined as students' decision making or community organizing to positively affect the team or club.

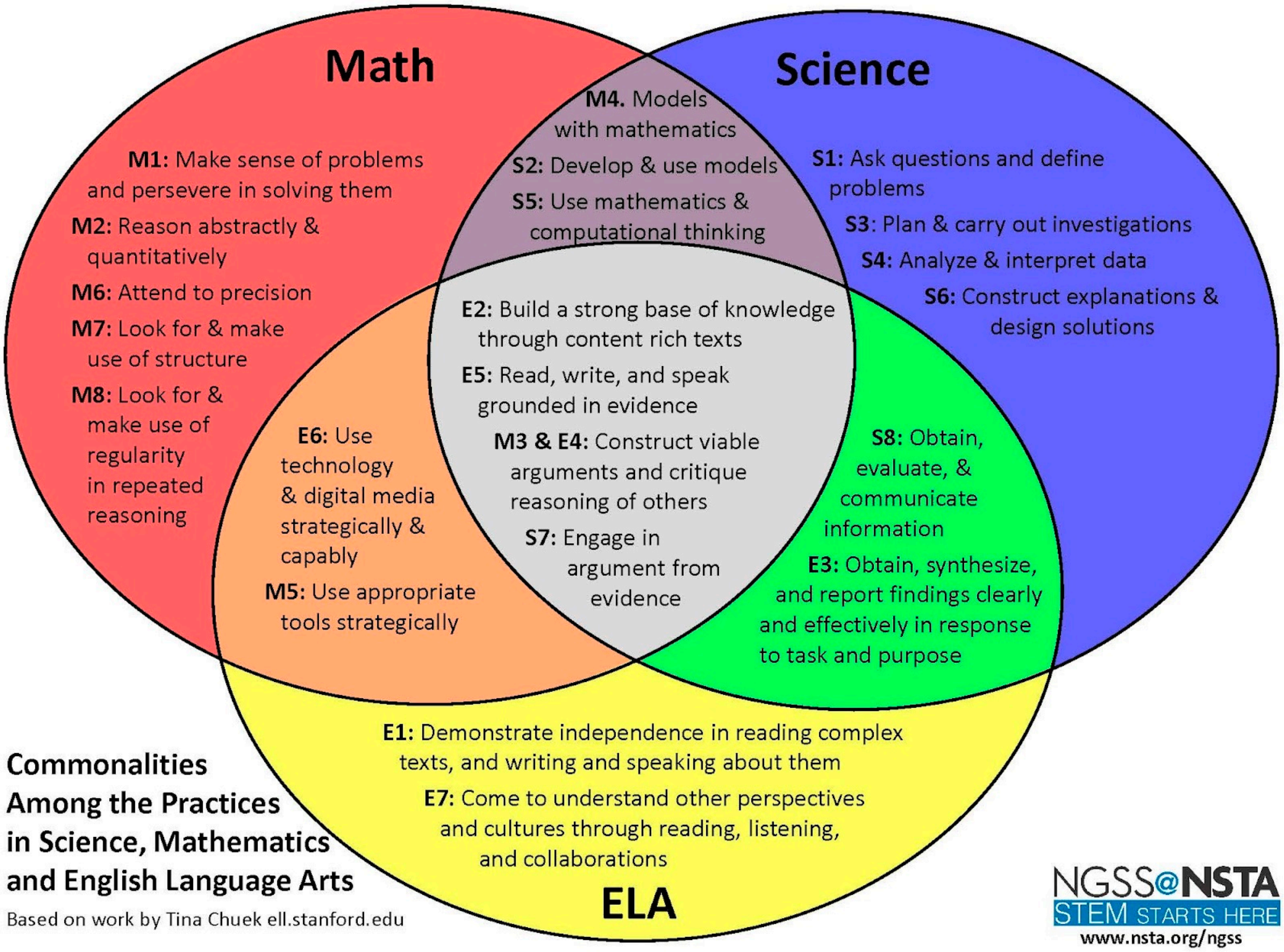

Figure 1. Academic content standards (Stage et al., 2013).

Four researchers coded the entire data corpus with four-way interrater reliability; 10% of the corpus was selected at random and coded by the four researchers independently. Agreement was defined as a four-way match on each turn of talk, yielding an interrater reliability of 92.31%. Codes are not mutually exclusive, 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 codes 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 2×2 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. Boschloo's exact test (Boschloo, 1970), with a null hypothesis of independence between codes, was therefore chosen in their stead. Odds ratios and their 95% confidence intervals 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.

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)

Table 2. Coding scheme (with source in parentheses).

To test for differences by school income level, we categorized each of the six school sites 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 and Student Leadership

Mentorship yielded four significant results across science, math, and ELA domains (see Table 3). "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). Nonsignificant 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 toward higher values. 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.

	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

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

Table 3. Learning standards' dependence on Mentorship & Student Leadership.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 1, suggesting the opposite. "Use Evidence" has an odds ratio greater than 1 (2.06) and a confidence interval that is skewed above 1, along with a smaller, but nonsignificant *p* value.

Equity

We investigated whether outcomes were the same for students in low- and 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 shifting from high income to low income. The science standard of "Analyzing & Interpreting Data" showed the greatest gain for low-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.

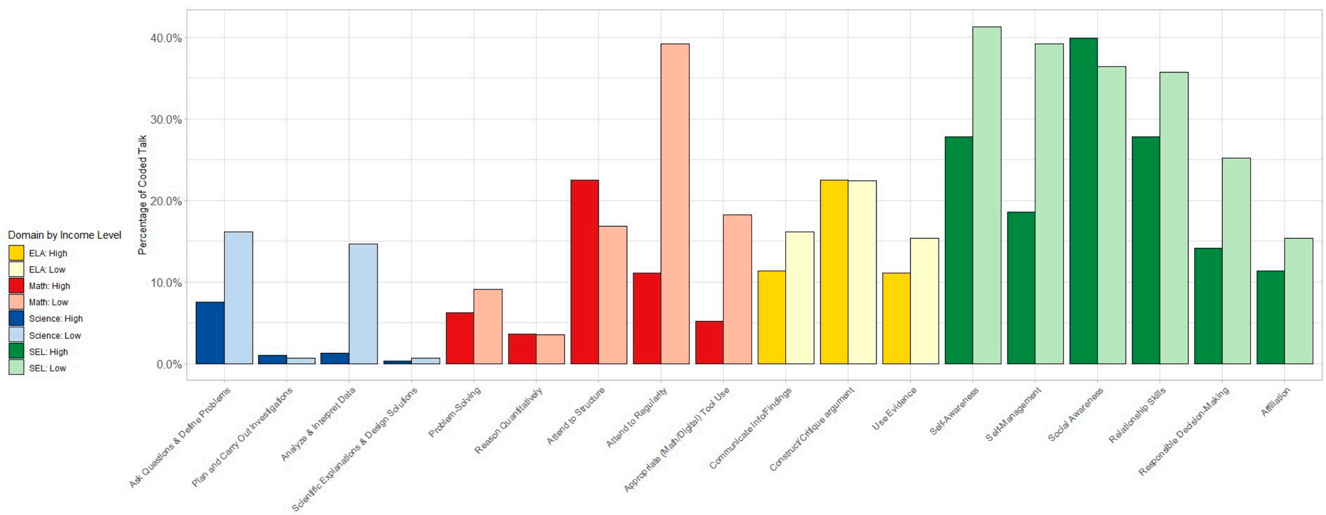

Figure 2. Student learning indicators across four domains (science, math, English language arts, SEL) by school income level.

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

Table 4. Dependence of learning standards on school income level.

Discussion

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 (Cho et al., 2019), while providing a more detailed window into the natural outcomes of students' participation in a school-affiliated high school esports league.

Science and Math

Science and math appear to be a natural part of students' NASEF activities. 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 their own performance (35% of such cases), the performance of their team (50%), or the performance of their opponent (17%). Scientific forms of reasoning, in contrast, appear to be more potential than actualized outcomes, with greater evidence of the early phases of scientific inquiry—such as defining problems (S1)—than the latter phases of the scientific process—such as developing scientific explanations (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 afterschool 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 gameplaying 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

There is a striking emphasis on SEL 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. 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)

Students also remarked on the role the league had in increasing their affiliation with school. Acknowledging students' interests and making a space for their game-related accomplishments made students 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 (see Figure 2), contrary to initial concerns about the equity of esports-based programming for high schoolers based on prior research. Cho et al.'s (2019) 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 and 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 and analytical skills. Having experts model best practices for team play and success gave students tangible actions to take to each game. Over the course of the season, both students and staff reported changes in the way students spoke to each other. 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. In these results and those of Cho et al. (2019), the presence of near-peer coaches helped encourage self-reflection and positive communication skills. 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, NASEF has evolved its afterschool programming from a mentored competitive league to a full-service afterschool enriched esports club structure supporting not only in-game competitors but also strategists, content creators, organizers, and entrepreneurs (Anderson et al., 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 was to be made available for schools in Fall 2019. The next step 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 United States: For students passionate about esports, school-affiliated competitive gaming can foster environments for interest-driven learning. Most noteworthy are the SEL gains reported by both students and staff. Both qualitative (Cho et al., 2019) and quantitative findings highlight how the esports league fostered self- and social awareness and regulatory skills. For many teens, the competitive frame that esports provides around video gameplay 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 a means for rehumanizing online gaming generally.

Contrary to initial concerns about equity by income, overall positive outcomes tend to favor lower-income schools. This finding is 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 (Steinkuehler & King, 2009). 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 CL model itself, demonstrating that 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 social-emotional development.

References

Anderson, C. G., Tsaasan, A. M., Reitman, J. G., Lee, J. S., Wu, M., Steel, H., … Steinkuehler, C. (2018). Understanding esports as a STEM career ready curriculum in the wild. In 2018 *10th International Conference on Virtual Worlds and Games for Serious Applications* (VS-Games). IEEE. https://doi.org/10.1109/VS-Games.2018.8493445

Boschloo, R. (1970). Raised conditional level of significance for the 2 × 2-table when testing the equality of two probabilities. *Statistica Neerlandica*, 24(1), 1–9. https://doi.org/10.1111/j.1467-9574.1970.tb00104.x

Cho, A., Tsaasan, A. M., & Steinkuehler, C. (2019). The building blocks of an educational esports league: Lessons from year one in Orange County high schools. In *Proceedings of the 14th International Conference on the Foundations of Digital Games*. ACM. https://doi.org/10.1145/3337722.3337738

Clark, D., Nelson, B., Sengupta, P., & D'Angelo, C. (2009). Rethinking science learning through digital games and simulations: Genres, examples, and evidence. Presented at the Learning Science: Computer Games, Simulations, and Education Workshop sponsored by the National Academy of Sciences, Washington, DC.

Collaborative for Academic, Social, and Emotional Learning. (2019). Core SEL competencies. Retrieved from https://casel.org/core-competencies/

Connected Camps. (2019). About us. Retrieved from https://connectedcamps.com/about

Gee, J. P. (2003). What video games have to teach us about literacy and learning. *Computers in Entertainment*, 1(1), 1–4.

Hayes, E. (2008). Girls, gaming and trajectories of IT expertise. In Y. B. Kafai, C. Heeter, J. Denner, & J Y. Sun (Eds.), *Beyond Barbie and Mortal Kombat: New perspectives on gender and computer games* (pp. 138–194). Cambridge, MA: The MIT Press.

Ito, M., Gutiérrez, K., Livingstone, S., Penuel, B., Rhodes, J., Salen, K., … Watkins, S.C. (2013). *Connected learning: An agenda for research and design.* Irvine, CA: Digital Media and Learning Research Hub.

Kempe-Cook, L., Sher, S. T., & Su, N. M. (2019). Behind the voices: The practice and challenges of esports casters. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. ACM. https://doi.org/10.1145/3290605.3300795

Kow, Y.M., Young, T., & Salen-Tekinbaş, K. (2014). *Crafting the metagame: Connected learning in the Starcraft II community.* Irvine, CA: Digital Media and Learning Research Hub. Retrieved from https://dmlhub.net/wp-content/uploads/files/craftingthemetagame.pdf

National Science Teaching Association. (2014). NGSS hub. Retrieved from https://www.nsta.org/ngss

Reitman, J. G., Anderson-Coto, M. J., Wu, M., Lee, J. S., & Steinkuehler, C. (2019). Esports research: A literature review. *Games and Culture*, 15(1), 32–50. https://doi.org/10.1177/1555412019840892

Riot Games. (2009). *League of legends* [Computer game]. Los Angeles, CA: Riot Games.

Stage, E. K., Asturias, H., Cheuk, T., Daro, P. A., & Hampton, S. B. (2013). Opportunities and challenges in next generation standards. *Science*, 340(6130), 276–277. https://doi.org/10.1126/science.1234011

Steinkuehler, C., & Duncan, S. (2008). Scientific habits of mind in virtual worlds. *Journal of Science Education and Technology*, 17(6), 530–543. https://doi.org/10.1007/s10956-008-9120-8

Steinkuehler, C., & King, E. (2009). Digital literacies for the disengaged: Creating after school contexts to support boys' game-based literacy skills. *On the Horizon*, 17(1), 47–59. https://doi.org/10.1108/10748120910936144

U.S. Department of Education. (2018). *Improving basic programs operated by local educational agencies (Title I, Part A)*. Retrieved from https://www2.ed.gov/programs/titleiparta/index.html

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