AC 2011-1057: PROMOTING DIVERSITY AND PUBLIC SCHOOL SUCCESS IN FIRST LEGO LEAGUE STATE COMPETITIONS

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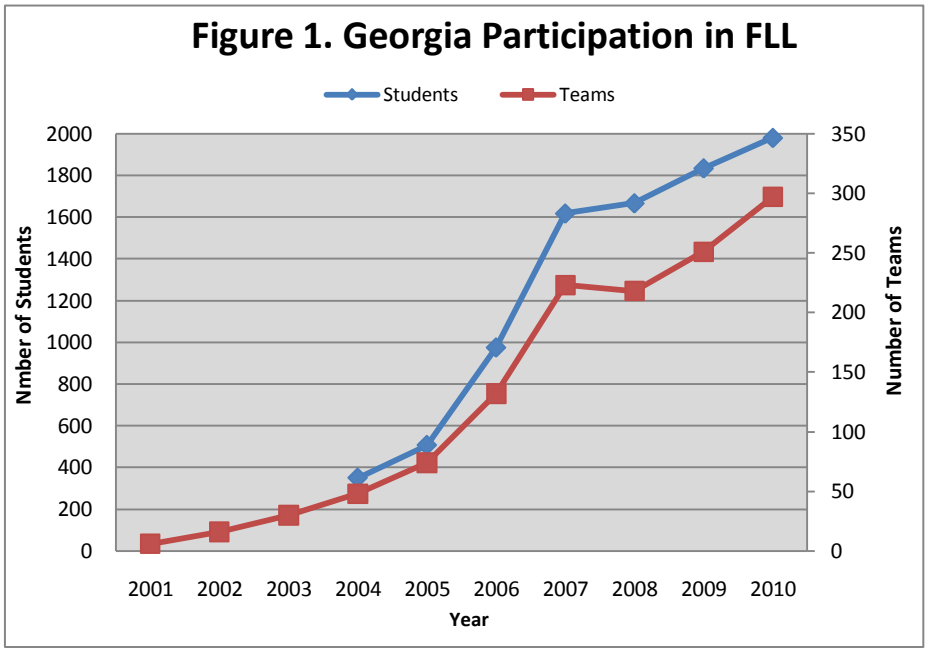
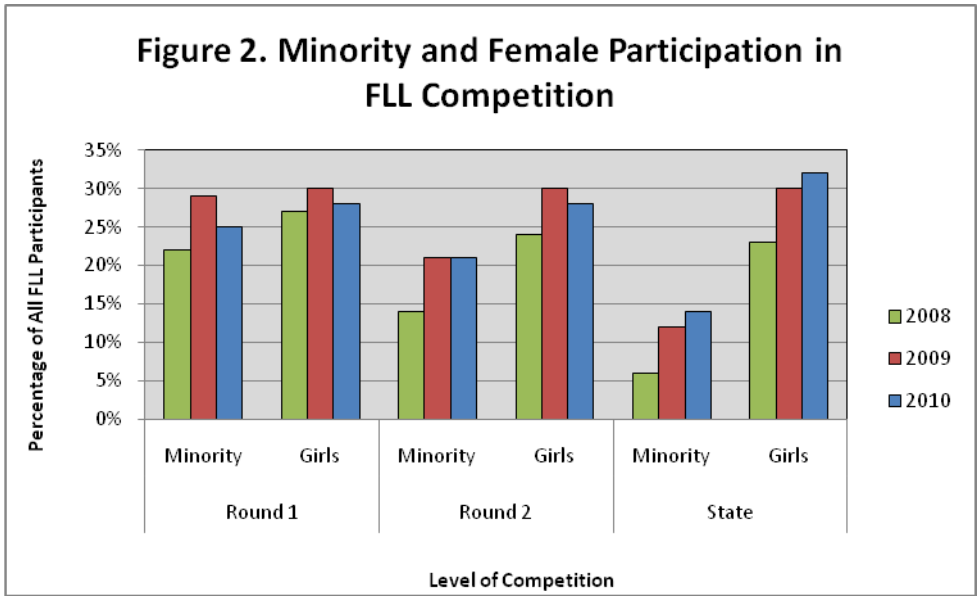
Promoting Diversity and Public School Success in First Lego League State Competitions

Introduction

Many studies have shown, at least anecdotally, that robotics activities and competitions such as FIRST LEGO League (FLL) can successfully promote K-12 student engagement in, and mastery of, engineering skills and habits of mind [1,2,3,4,5,6,7,8,9]. Robinson (2005) also provides evidence that classroom activities utilizing LEGO Mindstorm robotics can help develop language skills in limited English proficiency (LEP) students by promoting inquiry and student discussion[10]. Generally the benefits of these types of activities are limited primarily to students who self-select into after-school robotics clubs or summer programs, or who live in neighborhoods where parents have the time, resources and knowledge to successfully coordinate and coach a FLL team. Without intervention, these common pathways to participation too often rule out active involvement by low income students in many predominantly minority schools.



The State of Georgia has a highly successful state FLL tournament series that has grown in size from 48 teams in 2004 to 297 teams in 2010 (Figure 1), and currently serves approximately 2,000 students annually (Figure 1). In 2010, the Georgia FLL tournament series consisted of twelve first-round qualifier competitions held on two Saturdays in late fall, three second-round super-qualifier competitions held in early January, and a single State-level competition. Girls and under-represented minorities (African American and Hispanic) consistently make up between 22% and 30% of the student participants in Round 1 (Figure 2). Though the percent of participants who are girls remains fairly constant through Round 2 and the State competition, the representation by minority students drops substantially in the later rounds. However Figure 2 shows a notable increase in participation by minorities in the later rounds in 2009 and 2010, as compared to 2008. This paper addresses some of the reasons for this improvement.



Minority Involvement in FLL

We have previously reported[11] that minority students, on average, experience FLL under somewhat different circumstances than non-minority (Caucasian and Asian) students. For example, minority students are more likely than non-minority students to be involved in FLL through a public school, rather than a private school, home school, or independent (non-school-affiliated) team. In addition, though the majority of the FLL teams overall (74%) participated in FLL through extracurricular clubs rather than within normal school day classes, under-represented minority students were more likely than non-minority students to participate in FLL within the school day curriculum rather than in an extracurricular club (38% vs. 24% in 2006). This presents a challenge for the teacher/coach as FLL is subject to normal school day constraints of time and standards-based learning.

FLL teams located within regular schools, both public and private, are at a distinct competitive disadvantage in many ways when compared to home school and independent teams. School teams generally meet one day per week outside of the school day, often for less than 2 hours, whereas home school and independent teams can dedicate many hours per week to the activity. In addition, school teams tend to have more frequent turnover of students and coaches than non-school teams, and are more inclusive about which students they allow to participate. These differences give home school and independent teams a huge competitive advantage in the tournament over their school-based peers.

It is common knowledge in FLL circles that home school and independent teams are hugely over-represented among the top scoring teams. This general observation was exemplified over a two year period in Georgia (2006 and 2007), when 15 of the top 20 awards given at the state competition went to non-school based teams, even though 80% of the 335 teams that first registered with FLL that year were based at schools[12]. In 2006, not a single minority student in Georgia was part of a non-school based team, so it is not surprising that minority students were not well represented in the top tier of teams, or even in the state tournament. The vast majority

of minority students were eliminated in the first round of the tournament, giving them few opportunities to actually compete against another team. When the competition is particularly skewed, and low income minority public school teams are pitted from the start against highly coached suburban neighborhood teams, the whole experience runs the risk of being a very discouraging experience for students on the minority teams.

Since the objective of FIRST LEGO League is to create a competition tournament that promotes high level engineering and academic engagement in students by providing the most rewarding experience possible for the largest group of students, we chose to implement a system that calculates a "Power Rating" for each team, and structures the tournament series to promote, as much as possible, early round competitions between teams from similar backgrounds. We call this our "NCAA Basketball Tournament" model of tournament design—teams compete against similar teams during the early rounds (in the NCAA, this is during the regular season), and then all come together for the final tournament. The expectation is that teams from the power conferences (in this case, non-school-based teams) will ultimately wind up winning the top awards at the state level. Novice teams, however, also have a chance to observe other teams' solutions to program challenges, redesign their own robots, hone their skills by participating in multiple rounds of competition, taste success in those early rounds against similar opponents, and to have the thrill of going to the state competition. Being blown away by highly experienced opponents at the beginning of the tournament effectively limits the ability of these novice teams to practice, learn, and excel.

FLL Power Rating Scores

For the 2008 FLL season, we piloted a Power Rating score for the first time. This rating took into account:

1. The experience of the organization.
2. The experience of the coach.
3. The number of students returning from prior years.
4. The number of hours per week spent on FLL.

In 2009 we modified this score to also include a rating for what type of team it is—primarily school-based vs. non-school based. Teams organized by non-profit youth or community organizations, such as the 100 Black Men, or the Girl Scouts, were assigned the same rating as school-based teams, rather than independent teams.

The scores were calculated using the following values and points are assigned based on input from the coach during the registration process. Prior experience refers to how the team performed the preceding year.

Sponsoring Organization
(Points)

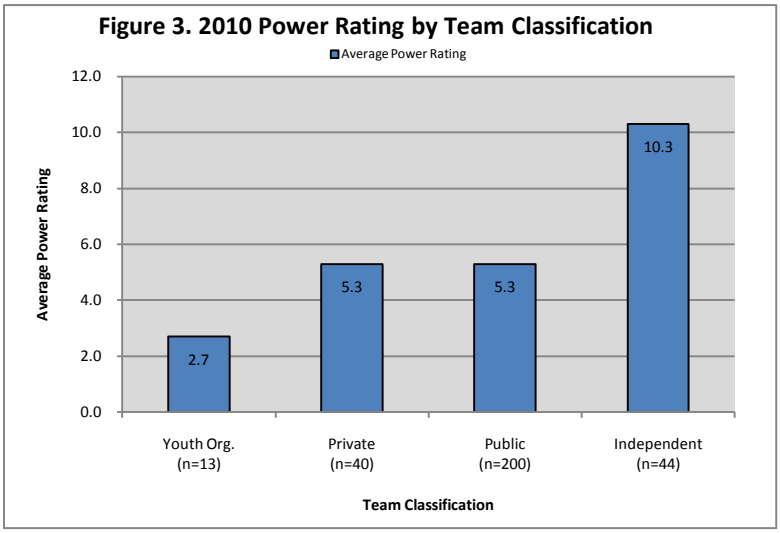
0 No prior FLL experience.
1 Participated only in the 1st qualifying round.
2 Advanced to the 2nd round.
3 Advanced to the State Competition.

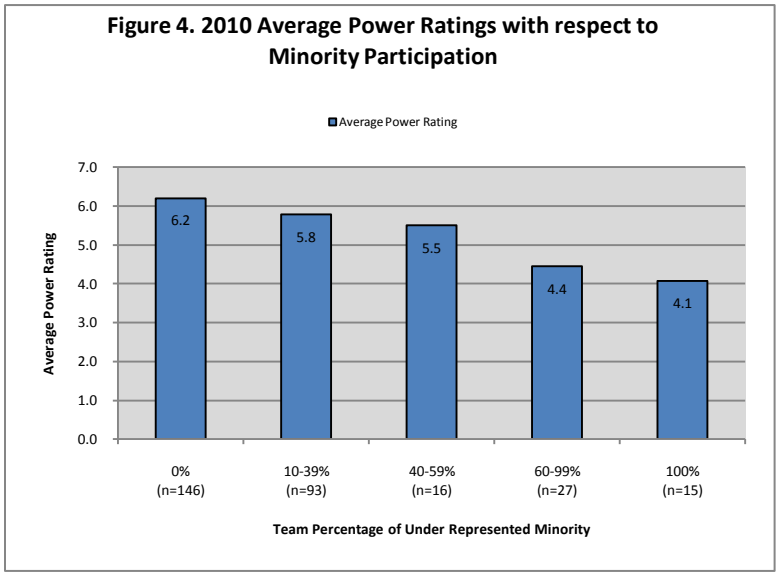
4 Has participated in the State Competition for multiple years.
5 Won a performance award at the State Competition last year.

Coach
0 New coach.
1 Participated only in the 1st qualifying round.
2 Advanced to the 2nd round.
3 Advanced to the State Competition.
4 Won a performance award at the State Competition last year.

Students
0 All new students
1 10-20% returning from previous year
2 30-50% returning from previous year
4 >50% returning from previous year

Hours Spent on FLL per Week
0 < 2 hours
1 2-3.5 hours
3 4-6 hours
4 > 6 hours





Type of Team
0 Public or private school, or non-profit youth or community organization
3 Independent or home school team.

The power rating of the teams can range from a score of zero, for the brand new public school team with no experience and one 90 minute meeting during or after school per week, to a score of 20 for an experienced home school or independent team that is returning after having won a performance award the previous year and plans to dedicate more than six hours per week to FLL.

Power Ratings by Type of Team and Percent Minority

Figure 3 shows the average power ratings of different types of teams in 2010. Not surprisingly, youth organization-based teams had the lowest power ratings, and independent teams had the

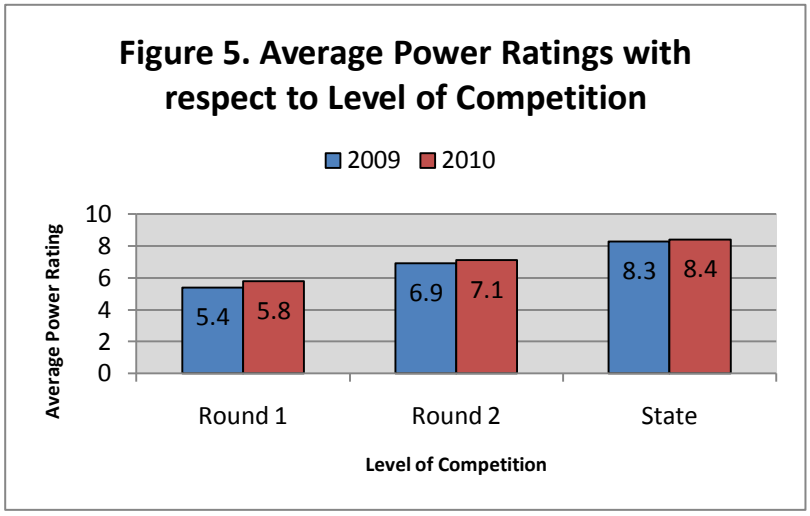
highest. Teams with the highest percent minority representation had the lowest power rating (Figure 4). These data held true for 2009 teams as well.

Use of Power Rating to Assign Teams to Qualifying Competitions

The basic reason to assign power ratings was to give an objective score to teams to help group them appropriately during the tournament series. The first-round qualifier competitions were coordinated by volunteers, generally school system personnel or experienced FLL coaches. Nine of the twelve first-round 2010 competitions were in the metro-Atlanta area, where the bulk of the teams are located. The other three were distributed geographically around the state. Four of the nine metro-Atlanta competitions were coordinated by school systems, and five were coordinated by other volunteers.

During the registration process, Georgia FLL teams were asked to give their first six choices for which competition they would like to attend. Tournament coordinators then used a set of rules to assign teams by hand to competitions. These rules were:

1. If a school system coordinates a competition, then public schools from that system are given top priority for that competition.
2. Private schools, home schools and independent teams have priority at two of the competitions, one on each of the available Saturdays.
3. Teams not associated with public school systems may attend school system competitions only if their power rating is comparable to the power rating of the majority of the teams already assigned to that competition.
4. A reasonable attempt is made to always assign teams to competitions where they will compete against teams with a similar power rating.
5. The non-metro-Atlanta tournaments are open to any teams from that geographic area, regardless of power rating.



Results

Figure 5 shows the average Power Ratings for Round 1, Round 2 and the State Competition. Table 1 shows the percentage of teams in each power rating range that progressed to the different rounds of the tournament.

Table 1

Team Power Rating	# in Round 1	% advanced to Round 2	% advanced to State
0-5	132	30%	8%
6-10	95	43%	19%
11-20	37	73%	43%

Clearly, the Power Rating is a fairly accurate general predictor of whether a team will progress to further rounds of the FLL tournament.

One of the goals of implementing the power rating scale, and assigning teams to qualifying competitions based partially on their power rating, was to increase the number of minority students who progressed to a second round. The twelve 2010 qualifying competitions ranged in average power rating from 4.3, for a 60% minority inner city competition, to 9.2 for a home school and independent team focused competition that included only 6% minority students. Each competition sent a proportional number of teams to the Round 2 super-qualifying competition. In 2007, before the implementation of the super-regional round, only 16% of minority students competed in a second tournament. In 2008, when we first piloted the power rating scale, 22% of minorities progressed to a second round. By 2010, with the full implementation of the power rating system, 37% of minority students were able to compete in a second round, providing them both with a chance to develop their skills, and a much more satisfying tournament experience.

Conclusions

Implementing the power rating scale has enabled us to create a tournament series that intentionally promotes competition between similar teams, thereby creating an experience that better promotes student engagement by providing students with the most rewarding tournament experience possible. The FLL competition consists of more than just a robot performance, and with teams advancing to additional rounds they are afforded time to continue to work on their project and robot. While at the competition, collaboration amongst teams flourishes, as students have the opportunity to see and discuss other designs and competitive strategies. Debriefing from the prior round of competition is then focused on adjustments to improve their performance at the next level.

This experience at additional levels of competition also sets a tone for the improvement of the team in the following year. Members that compete in FLL from year to year not only gain a greater understanding of the objectives of the program, but they are equipped with a better concept of how to construct a vehicle and the strategy that allows them to complete more of the competition missions. The intrinsic value of the system is that the student experiences a level of success that motivates them to improve and drives a desire to continue to learn. With this enthusiasm, teams that were once lost in the shuffle of early round competition are capable of competing at a higher level in the following years.

To avoid any issues implementing such a system, we inform coaches about the process ahead of time, and have received very few complaints about the system. The process of assigning teams,

however, requires thought and attention, and can be quite labor intensive. The less attention given, the more likely it is that mismatched teams will end up in a tournament, and strong, independent teams will end up winning most honors in an otherwise low-power competition.

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