



Executive Summary

Arizona Division Placements, Jan. 20, 2015

Overview:

The Arizona Interscholastic Association (AIA), based on Board direction of Oct. 20, 2014, started the process to look at a new way of classifying member schools into divisions. The AIA staff attended conference committee meetings and obtained feedback from those conference committees and coaches as well.

AIA staff presented the feedback to the Board on Nov. 17, 2014, and based on Board direction, AIA staff solicited the assistance of two consultants, Mr. Jameson Quinn (studying for PhD in statistics) and Dr. Andrew Jennings, to develop a formula to classify member schools by division. It was confirmed at that time that the current process of classifying member schools strictly based on enrollment was no longer working, and didn't adequately reflect a member schools level of competition.

On Dec. 8, 2014, an update was provided to the Board, with feedback from the developers to utilize objective data within the formula that would include enrollment, free and reduced lunch numbers, and MaxPreps records and rankings history (the rankings formula that includes a capped score differential as utilized by MaxPreps, and not the rankings as seen on AIA365.com).

The following is the Executive Summary as provided by the consultants:

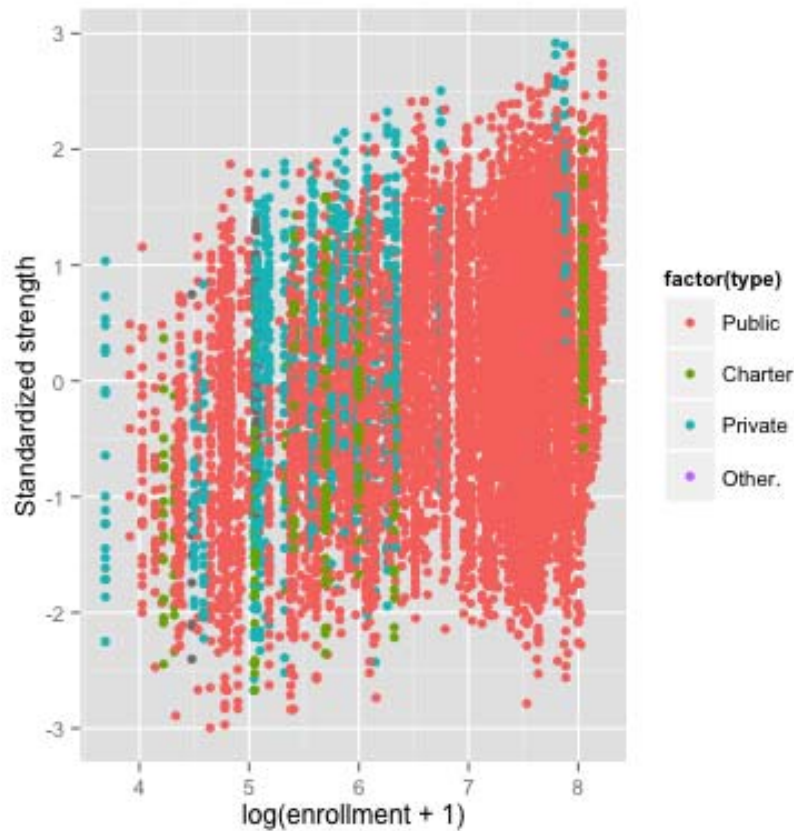
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How should Arizona high school teams be assigned to sports divisions? The ideal assignments would ensure that teams are as fairly matched as possible within each division, while maintaining enough stability to avoid excessive division changes. In other words, if we could somehow know numbers corresponding to the true average strength of each team over the next several years, we'd want to set up divisions such that the standard deviation within each division of those numbers was at a minimum.

Unfortunately, of course, we cannot know such numbers. We have no crystal balls to predict the future. And, even for the past, we don't know a team's true strength, only their game record. This record may be affected by luck in individual games; and it also has systematically fewer inter-league games than intra-league ones, making the measures of inter-league strength more haphazard.

Still, a systematic analysis of the record we do have shows certain clear patterns. First off, it can tell us how much stronger a larger school can hope to do than a smaller one. Our analysis proceeded on the presumption that this effect can be different for each sport, but not too different; in technical terms, the individual effects for each sport were estimated separately and then "regularized" towards a common mean. Here is a graph showing the overall, cross-sport effect:

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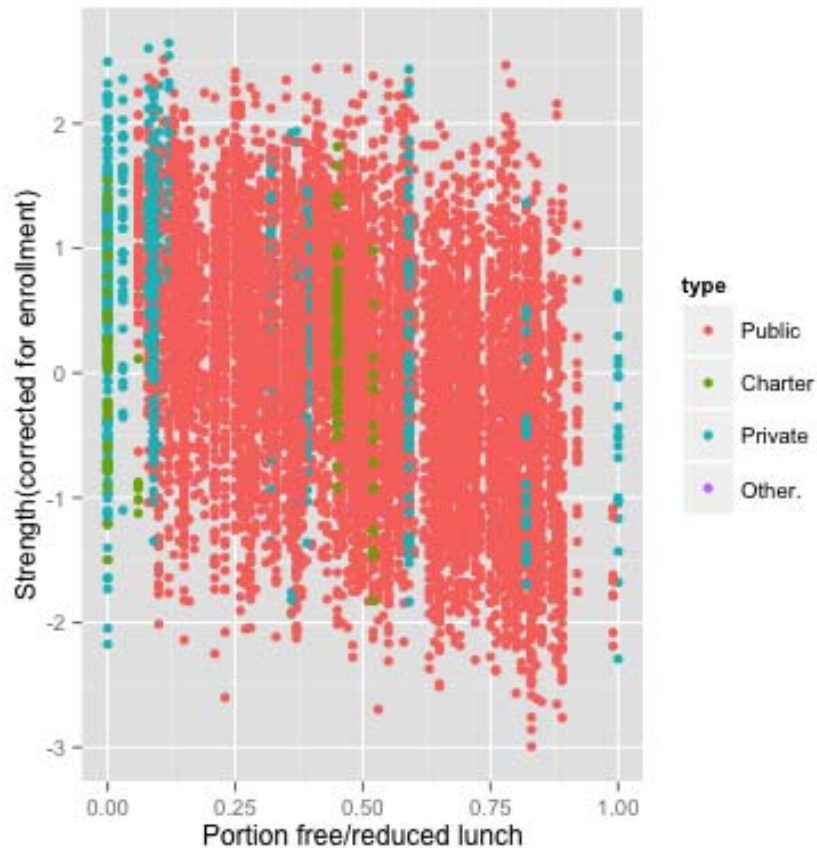


Clearly, larger enrollment is associated with better performance, but there is a significant amount of variability still unaccounted-for by enrollment alone.

One possible source of this variability is school demographics. Specifically, the percentage of free- and reduced-price lunches in a school's population is a generally accepted proxy for the overall average socioeconomic status of a school. Here's how well that associates with performance, after correcting for enrollment:

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Again, the trend is clear, but variability remains.

This leads to a formula for predicting a school's strength based on demographics (that is, enrollment and free-lunch portion) alone:

$$t = (p \times \log(\text{corrected.enrollment}) + q \times \text{free.reduced.lunch})$$

The factors p and q vary from sport to sport, with p running from 0.051 standard deviations per doubling for football up to 0.50 standard deviations per doubling for boy's soccer, and q running from -.08 standard deviations per 10% for boy's basketball to -.17 standard deviations per 10% for girl's soccer.

Still, this formula only accounts for about 22% of the variability in yearly performance. How much of the remaining variability is due to transient factors like luck and individual star players, and how much can be expected to persist into the future? In order to answer this question, we built an autoregressive moving average (ARMA) model capable of simulating future results. Two moving-average coefficients were fit across all sports, to account for the enduring effects of star players across 1- or 2-year differentials; and 1 autoregressive coefficient was fit individually for each sport,



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then regularized towards a common mean, to account for other transient effects. The results were used to create a new formula for each sport:

$$f = s \times \text{median}(\text{last.six.years}) + (1 - s) \times t$$

This formula takes the demographic prediction t from the first formula, and combines it with a school's median performance over the last 6 years using a weight factor s . An s of 0 would mean that demographics was all that mattered; an s of 1 would mean that a team's history was all that mattered. In practice, s was estimated to vary from 0.28 for boy's basketball up to 0.52 for girl's tennis.

Thus, putting the two formulas together results in giving each school a number f , which represents the statistical prediction of its long-term strength. In theory, this number could then be used to assign schools to divisions. However, in practice, this would lead to some extreme changes from the current assignments. This could be unadvisable for two reasons. First, it is simply disruptive. And second, as mentioned above, the estimated strength numbers we have been using as a basis for all the above statistics are less reliable across divisions, especially across a gap of multiple divisions.

As a compromise, the above formula could be used to make adjustments to the current enrollment-based divisions. To see what that would look like, we have developed two separate recommendations:

fdiv_1step: This takes enrollment-based divisions, and moves each school 1 step towards the division it would have under the formula above. An exception is made for new schools without any history, which are not moved up based on the formula.

fdiv_1or2steps: This takes the fdiv_1step division assignments, and moves some schools one step further if three conditions are satisfied: that this would not take them from the very bottom to the top division (only possible in sports with only 3 divisions); that the demographic and historical formulas agree on which direction to move them; and that the full formula would suggest moving them by far enough (3 steps or to an extreme).

AIA Conclusion:

It was recommended and approved by the AIA Board to limit the movement for initial division placement based on the "fdiv_1step" approach. That is, the initial division placements would not move a school based on the strength based formula more than one division in either direction from where that school was placed based on enrollment-based placements.

For example, if a school was placed in D-III by enrollment, but the formula placed the school in D-I, the school would be placed in D-II. It would work in the reverse as well. If a school was placed in D-I based on enrollment, and the formula placed the school in D-III, the school would be placed in D-II.



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The initial division placements are for the 2015-2018 three-year block. As can be seen by the initial division placements, the division sizes are unequal. This is because, *when you restrict how much schools can shift, they can shift into the middle divisions from two directions, but into the extremes from only one direction.* Member schools can follow the process and timeline to appeal their initial division placement.

It is important to keep in mind with regard to unequal division sizes, based on board approval of Dec. 8, 2014, the amount of teams from each division that qualify for state tournaments will be based on a 30% rule, meaning 30% of the teams that compete in that division will qualify for state tournament play. The exception is football in which no less than 12 and no more than 16 will qualify per division, and basketball where no less than 16 and no more than 24 will qualify per division.

Moving forward, the second part of the formula for strength, will be utilized to help the respective sport advisory committees make recommendations for schools to move up or down from their current division placement following the 2015-2018 three year block. Member schools will have the ability to appeal their movement as well as appeal their current division placement every two years (following the 2015-2018 three year block). This process will be followed every two years after the 2015-2018 three year block.

If you are interested in a more in-depth statistical and mathematic analysis as provided by Mr. Quinn please [click here](#).