
AC 2012-5112: AN INDEX TO AID IN THE DEVELOPMENT OF HIGH SCHOOL RECRUITMENT OF FUTURE ENGINEERING AND SCIENCE MAJORS

Prof. Galen E. Turner III, Louisiana Tech University

Dr. Kelly B. Crittenden, Louisiana Tech University

Kelly Crittenden is the Harrelson family endowed Associate Professor in the College of Engineering and Science at Louisiana Tech University. He received his Ph.D. in biomedical engineering from Louisiana Tech in 2001. His primary research areas include multidisciplinary engineering education, curriculum development, and product development.

Dr. James D. Nelson, Louisiana Tech University

Dr. Heath Tims, Louisiana Tech University

An index to aid in the development of High School recruitment of future Engineering and Science students

ABSTRACT

We propose an index to aid institutions of higher education to better target professional development programs for high school teachers and recruitment of students. In particular, we propose an index, f , of an institution of higher education, defined as the number of *feeder high schools* who have graduates enrolling in the institution $\geq f$, as a useful indicator for the selection of high schools with whom an institution should work in the areas of professional development and recruitment of students. Using this f -index for the College of Engineering and Science at Louisiana Tech University, we have been able to show how professional development programs with regional high schools have positively impacted student enrollment in our engineering and science degree programs.

INTRODUCTION

For many years, the College of Engineering and Science at Louisiana Tech University has struggled with sustaining its professional development programs for high school teachers and recruitment of high school students with ever decreasing resources. With funding for public higher education declining for the foreseeable future, the fundamental question facing higher education will be, “How do we create programs that are sustainable with limited resources?”

A list of the feeder high schools for a particular college or university as well as the number of students who enroll from those high schools are useful in evaluating future outreach programs. If we label the number of high schools who have graduates attending a university and the number of students, F_s , from each school (s) attending the university, then we can characterize the useful output of the feeder high schools through a single number, the f -index, for a given academic year.

In any given year, an institution of higher education has index f if f of the number of *feeder high schools*, H , have at least f students each entering the institution where the other $(H - f)$ schools have less than f students each. Cumulative f -indices can be easily created for periods of time consistent with a particular institutions outreach efforts.

The research reported here will focus on feeder high schools for the College of Engineering and Science at Louisiana Tech University. We suggest that the f -indices should be useful to any other institution as well.

ENROLLMENT VS. GRADUATION RATES

In many fields of study, the national retention to graduation numbers reported are computed based on a 6-year graduation rate. While government and industry partners often point to raw graduation rates as performance indicators for colleges and universities, it is often difficult for institutions to grapple with issues of students who enter under-prepared for their chosen programs of study. The proposed f -index in this paper allows an institution to quickly determine which of its feeder high schools have the most students attending the institution. If used wisely, resources for future recruitment efforts can be built around the evaluation of the f -index over multiple years and over periods of time (as defined by such things as when recruitment efforts began in a particular school).

In the following section, we highlight the f -indices with more specific data from the feeder high schools for the College of Engineering and Science at Louisiana Tech University.

F-INDEX AS A MEASURE FOR RECRUITMENT EFFORTS

To illustrate the index, we consider a particular year as an example. For the Fall 2008 Cohort of Freshman engineering and science students in our college at Louisiana Tech, the f -index is 8. That is, our college has 8 feeder high schools who each had at least 8 of their graduates enter as freshman. This obviously gives a lower bound on the total number of freshman in engineering and science in 2008 at $f^2 = 64$. Naturally, the total number of freshman (F_{total}) will be much larger than f^2 as f^2 ignores the feeder schools with less than f graduates attending as well as underestimates the total number of students from the f top feeder schools. In certain instances, it has been useful to define a proportionality constant k as

$$F_{total} = k f^2$$

We find empirically that k ranges between 6 and 9 for the College of Engineering and Science at Louisiana Tech university for each year starting in 2000. Figure 1. shows the f -index for 2007-08, here $k = 6$.

f-index for 2007-08

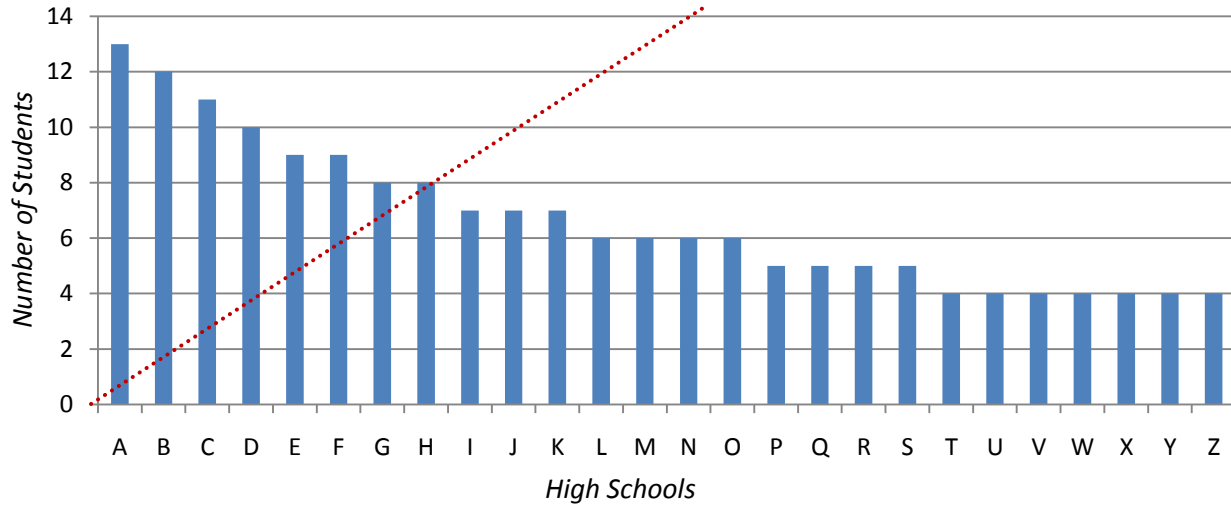


Figure 1. The *f*-index for 2007-08 in the College of Engineering and Science at Louisiana Tech University. The dashed line represents the diagonal line whose intersection with the distribution height of high school H serves as the graphic indication of the *f*-index, in this case $f=8$. Only the first 26 of 193 feeder high schools are shown.

Realizing that the *f*-index is rather limited in scope due to small sample sizes in a college that typically has around 400 incoming freshman with over 200 feeder schools, it is more reasonable to establish an *f*-index for a particular period of time.* In this setting, we say that the f_i -index is the *f*-index of all freshman entering over a period of i years. Unless it is obvious, we will typically place the year range in parenthesis after the f_i to indicate the exact period over which the data is being evaluated. For example, Figure 2. shows the f_3 -index for the three academic years 2007-08, 2008-09 and 2009-10 and is thus denoted, $f_3(2007-2010)$. This particular period has an $f_3=16$. Scaling this index over the number of years of data allows us to adjust for spikes in freshman enrollment in a single year and we can see that in this particular period that the average *f*-index is 5.33 while each of 2007-08, 2008-09 and 2009-10 academic year's *f*-indices were 8, 9, and 7 respectively. Thus, $f_3/3 = 5.33$ gives us a more reasonable view of our feeder high schools over the 3-year period by averaging out the spikes and drops in enrollment from particular feeder schools.

* We note here that this approach of viewing the feeder high school index is similar in format to the well-known *h*-index (or Hirsch-index)¹ which is commonly used to help characterize the scientific output of a researcher. The fundamental difference in our viewpoint is that we are looking at multiple indices of feeder high schools over periods of time. The Hirsch-index considers the total publication versus citation record over the lifetime of a researcher. The counterpart to our high school index would be the cumulative feeder high school enrollment number of the entire lifetime of the university. This number, while meaningful for historical reasons, does not really indicate anything practical in terms of recruitment efforts

$f_3(2007-2010)$

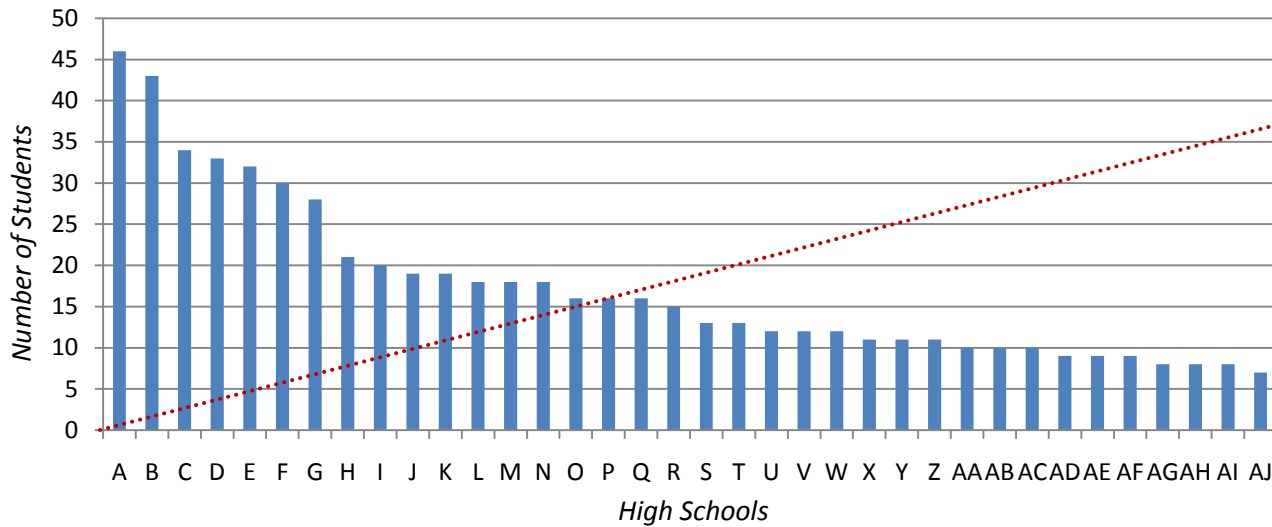


Figure 2. The f -index for the three academic years spanning 2007-10 in the College of Engineering and Science at Louisiana Tech University. The dashed line represents the diagonal line whose intersection with the distribution height of high school P serves as the graphic indication of the f -index, in this case $f_3(2007-10)=16$.

In short, the f_3 -index, as well as the individual f -indices over the same period of time, indicate that those feeder schools whose graduates number more than f_3 (or f) in any particular year are the ones that we should target for recruitment efforts. This leads to a question of how far below the f -index, for a given year, should institutions reach in order to include high schools who could potentially bring increased enrollment to the institution. Resources available for recruitment would dictate how far below the f -index one should consider going; but with limited resources, we believe that looking at multiple-year indices will help establish a reasonable cut-off for an interval in which we will have confidence of increased enrollment over time.

More to the point, if taken over the last decade, our f_{10} -index is 31, so that the 31 high schools who sent us at least 31 students over this period of time can be viewed as key feeder schools. Investigation of the various f_i -indices over this period of time helps reveal patterns of recruitment among these high schools. For example, since $f_{10}/10 = 3.1$, we observe that there are a significant number of feeder high schools that move from year-to-year above or below the typical f -index for a given year. In fact, we determined that there were a total of 23 high schools that, for at least one year, appeared above some f -index over this decade. This suggests that over a period of one decade, a ‘confidence interval’ for a given year should include many of the schools who appeared above some f -index for at least one year.

A naïve confidence interval for a given year’s f -index can be determined in a number of ways empirically. In the particular decade mentioned above, our f_{10} -index spanned the years 2000-2010. Using this same period of time, we observed that if we considered our list of schools

ordered by the number of students ‘sent’ to our college, we should expect a confidence interval to start at the school with the highest number and end at a number, c , of the form

$$c = af$$

If we choose to take c to be the largest possible point at which there are no more than $[f_{10}]$ schools ($[x]$ is the greatest integer function) who never appeared above an f -index for any of the decade, then empirically, we find that a ranges between 1.75 and 2.43 over the decade in question. Similarly, if we instead choose to take c to be the largest possible point at which there are no more than f schools who never appeared above an index for any of the decade, then empirically, we find that a ranges between 2.375 and 3.43 over the decade in question.

Our analysis suggests is that if we were to target recruitment efforts at schools within the confidence intervals above, then we would be more likely to increase the f -index for future years and thus increase overall enrollment within the college. For example, if our minimum k for our equation $F_{total} = kf^2$ were to remain near the value computed empirically ($k = 6$), and we were to increase the f -index in future years to be consistently 9, or even 10, then our enrollment should increase from roughly $6 \times 8^2 = 384$ to the numbers $6 \times 9^2 = 486$ or $6 \times 10^2 = 600$, respectively.

RECRUITMENT EFFORTS FOR SCHOOLS BELOW THE F-INDEX

Recruitment efforts in the College of Engineering and Science have been active for decades, however over the past 7 years, we have taken a more targeted approach to recruiting by developing meaningful relationships with high schools through professional development programs for their teachers.^{2,3,4} These programs have demonstrated significant increases in students entering our engineering and science programs from these key schools. A number of these schools have moved above the f -index for recent years demonstrating a measure of success for these programs. In the remainder of this paper, we will describe specific high schools and how the high school index has served as an indicator for success. Reference will be given to the ranking of each high school according to how many freshmen entered our college from that high school. Specifically, we consider only the top $f_{10} = 31$ high schools in any given year ranked from highest to lowest numbers of freshmen entering from that high school. We should also note that a lower ranking from one year to the next does not necessarily mean fewer students came from that school.

Airline High School (AHS) is a large high school in an urban area of Louisiana. In 2000, this high school was ranked 21st when ordered according to how many freshmen entered our college from the high school. For this year, the f -index is 7 and thus AHS is at 3×7 (the lower extreme point of one of the confidence intervals mentioned above). In 2001, AHS moved above the f -index of 7 for this year and was ranked 4th. In this same year, the first author was awarded a grant to design a professional development program in mathematics, and teachers from AHS attended this series of workshops and became a key target school for the college. For the year’s

2001, 2002, 2003 AHS was consistently near the f -indices for these years, ranked 4th, 10th, and 8th, respectively. In 2004, three of the authors teamed up to pilot a new professional development program, with AHS, which became the demonstration project for the NSF funded LaTechSTEP² program. In 2005 and 2006, AHS was ranked 2nd in the number of freshmen entering the college, and AHS remained ranked above the f -index for each year from 2005-06 through 2009-10. AHS is now considered one of our key feeder schools.

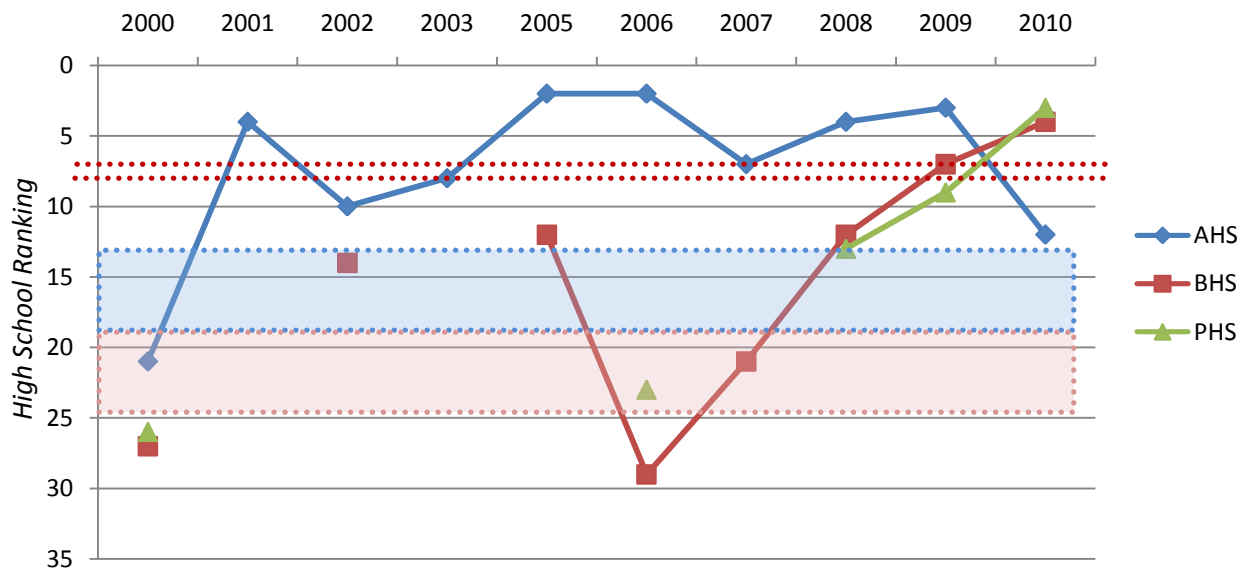


Figure 3. Three feeder high school rankings from the period 2000 - 2010. The red-dashed horizontal lines represent the f -indices of 7 and 8 that occur for this decade. The lightly shaded areas of light-blue and pink are the limits of the extremes for each of the two confidence intervals mentioned in the previous sections.

Benton High School (BHS) is a small-to-medium-size high school in a more rural area of the same school district as Airline High School. BHS was ranked 27th in 2000, outside of the confidence intervals mentioned above. BHS was not among the first 31 high schools in 2001 but showed up, and ranked 14th, in 2002 and then, again, did not show up among the first 31 ranked schools in 2003. As our LaTechSTEP program was coming on-line, we were approached by one of the teachers at BHS to help him with some of the programs that he wanted to start at their school. By 2005, BHS was consistently in the top 31 ranked schools. In 2008, BHS joined our LaTechSTEP program and participated in our pilot for our next-level professional development program, Cyber Discovery.^{5,6} In 2009, one of the lead teachers from BHS became a master teacher in our NASA-funded project to re-design a high school physics curriculum.^{7,8} Since 2008, BHS has been consistently ranked 12th or higher among our feeder high schools, where in the 2009-10 and 2010-11 academic years, they were above the f -index for those years.

Parkway High School (PHS) is a large high school in a sub-urban part of the same district as both Airline and Benton High Schools. PHS was ranked 26th in 2000, just above BHS and also

outside of the confidence intervals we have previously observed. PHS was not ranked in the top 31 high schools again until 2006 when they were ranked 23rd, and then were not ranked in 2007. In 2008, we invited them to participate with BHS in our Cyber Discovery program, and they have actively participated in that program ever since. In 2009, they joined our LaTechSTEP program and then implemented our new high school physics curriculum (titled, NASA-Threads) in 2010. Since 2008, PHS has also been consistently near the *f*-index, increasing each year, when they were ranked 3rd in the 2010-11 academic year cohort.

OBSERVATIONS FROM ABOVE THE F-INDEX

While recruitment efforts in the College of Engineering and Science have been very active, analyses of the various indices have revealed interesting patterns. One such pattern is a one-year spike in enrollment from particular high schools. For example, several high schools show up above the *f*-index for a given year and yet do not show up in the top 31 ranked high schools for the remainder of the decade. In cases we investigated, it became clear that one possibility was a new teacher, with ties to our college, who had been present for a year or two and then moved on to another school; another location had a new family who moved to town with ties to the college, and they made an extra effort to recruit for the college. While these observations were not made at the time, by looking back at these instances, we believe that with this new index, investigation of such a spike in the future could be identified quickly and leveraged to develop new relationships at a previously untapped high school with the long-term attempt to make recruitment more robust and stable at that high school.

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