An Analysis of the Impact of the Availability of NCEA Standards Upon Success at Achieving UE.

Rolf Turner
Starpath Project
The University of Auckland

COMPASS Seminar, 1/May/2009

Outline

- The Starpath project.
- A statistician in a strange land.
- The "standards deficit".
- Collecting data on "availability".
- Remarks on the data analysis.
- Highlights of the results.
- Conclusions and implications.

The Starpath Project

- The Starpath project is a "Partnership for Excellence" between the University of Auckland and TEC.
- It was set up (in 2005) largely at the instigation of Dame Anne Salmond, who remains Starpath's sponsor (and patron saint :-)).
- It is unique in that it is the only Partnership for Excellence whose funding was *not* largely allocated for the construction of buildings.
- The problem at which Starpath's efforts are directed is that of the under-participation of Māori and Pacific Island students (and more generally, students from low decile schools) in degree-level tertiary education.
- Its plan of action was formulated in terms of determining "choke-points" in the education system at which access to further education gets closed off to students.

Some Starpath Research

- Irena Madjar (leader of qualitative team): NCEA choices; the transition from high school to university.
- Samantha Smith (seconded from Massey High School): Academic counselling and target setting (implemented by Sam at Massey and now being trialled at other schools).
- Boaz Shulruf (my predecessor as leader of the quantitative team): A large number of projects relating to various factors which have an impact on success at getting to university and success at university.
- Boaz's work got some notoriety in the press because it showed that NCEA results predict success in first year uni (correlation c. 0.65) better than CIE results (correlation c. 0.32).

Starpath and Me

- I was recruited to join Starpath in late 2006, and actually joined them in mid-May 2007.
- It took me a long while to find my feet — actually I'm still working on it.
- Lots of jargon to learn; I'd never heard of NCEA or the NZQA.
- "Decile" was another puzzle.
- It was a struggle to get my head around the word "standard" as it is used in the NCEA context.
- The rules for achieving "UE" according to the NZQA criteria were pretty opaque to me.
- And then there was/is actually getting into (various programs at) e.g. the University of Auckland — as opposed to "just" getting UE.

Starpath and Me (Cont'd.)

- It took me quite a while to figure out just what I'm supposed to be doing.
- Planning research in a milieu which was totally unfamiliar to me was, to put it mildly, a challenge.
- It seemed that to a large extent I was hired under the assumption that statisticians can work magic. (This is not true; we're good, but we're not *that* good!)
- I have been constantly put in mind of Tukey's dictum:

> The combination of some data and an aching desire for an answer does not ensure that a reasonable answer can be extracted from the given body of data.

Getting to the Point

- Be that as it may, I have still managed to do some pieces of work which are, IMHO, pretty good.
- I am now going to describe in some detail what I consider to be the best of these.
- I will start by describing the route by which I came to this work.
- I think it is interesting that the final results, although very important, are at a great remove from the questions that initiated the research.

The Beginnings

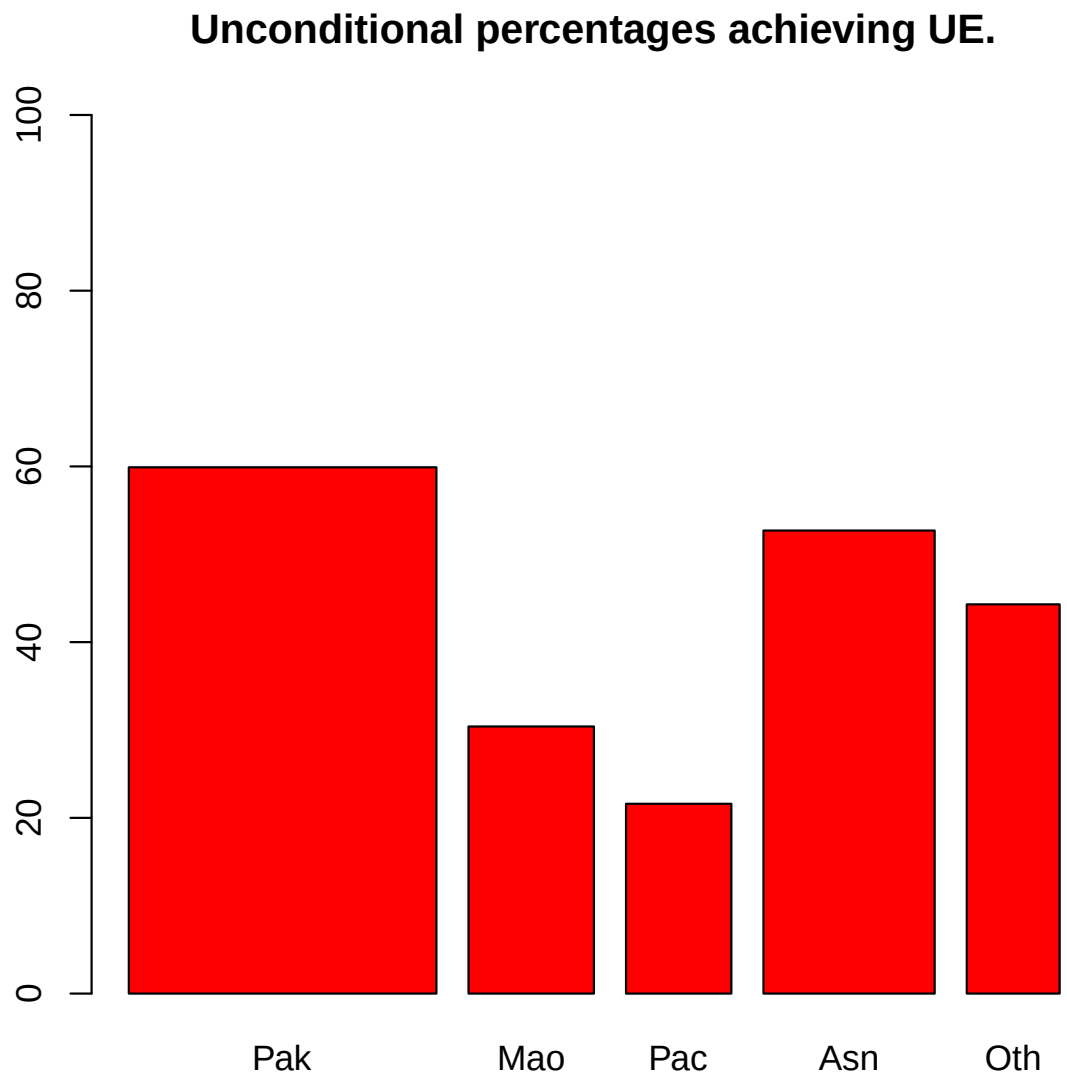
- It started with a brief presentation that I gave to a delegation from Qatar, that was visiting the Faculty of Education, a few months after I joined Starpath.
- Struggling to find something to talk to them about, I started thinking about some work that Sam Smith had done.
- There are effectively 4 components to the NZQA criterion for achieving UE. Sam investigated the question of which of these components (or which combination of components) tripped people up the most.

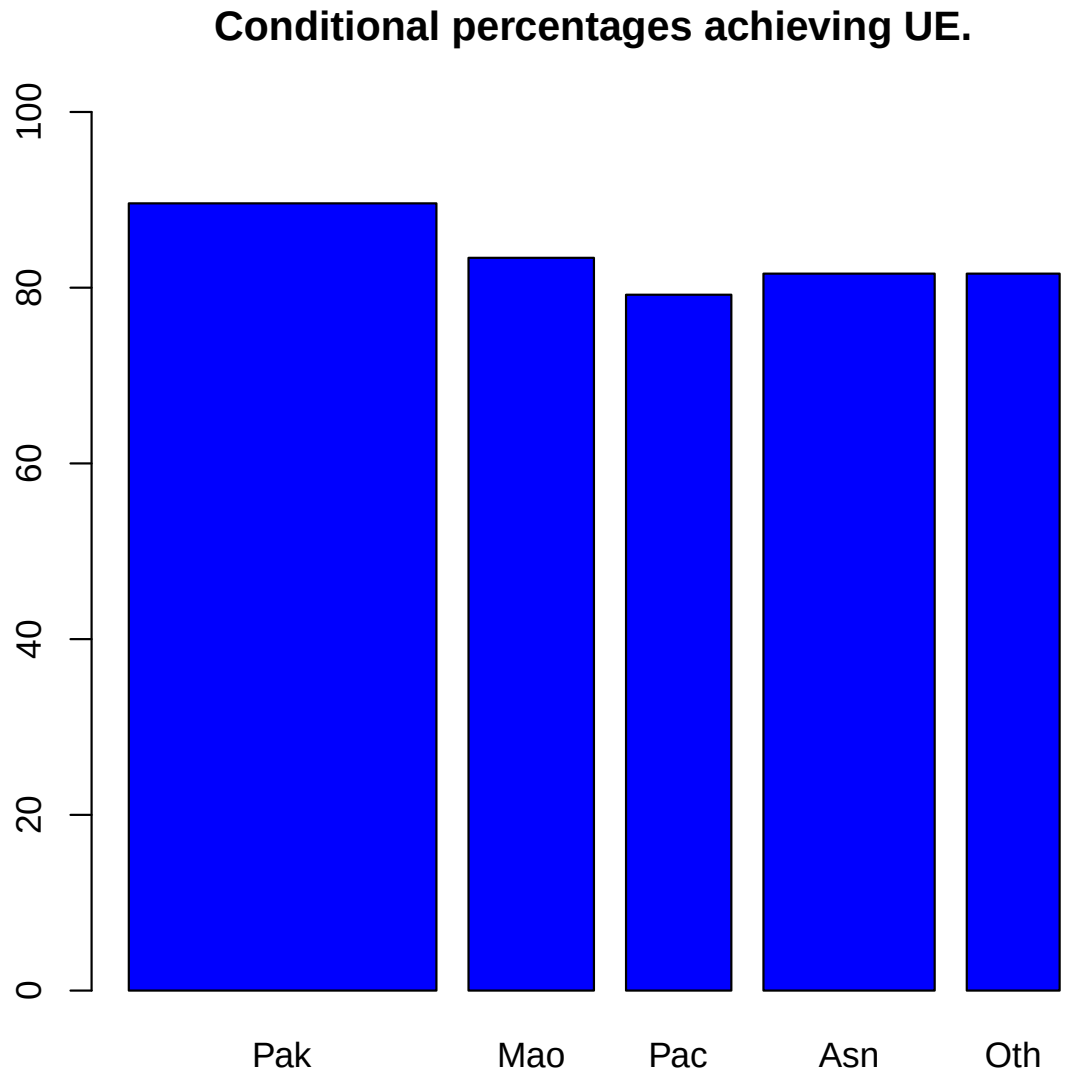
NZQA UE Requirements

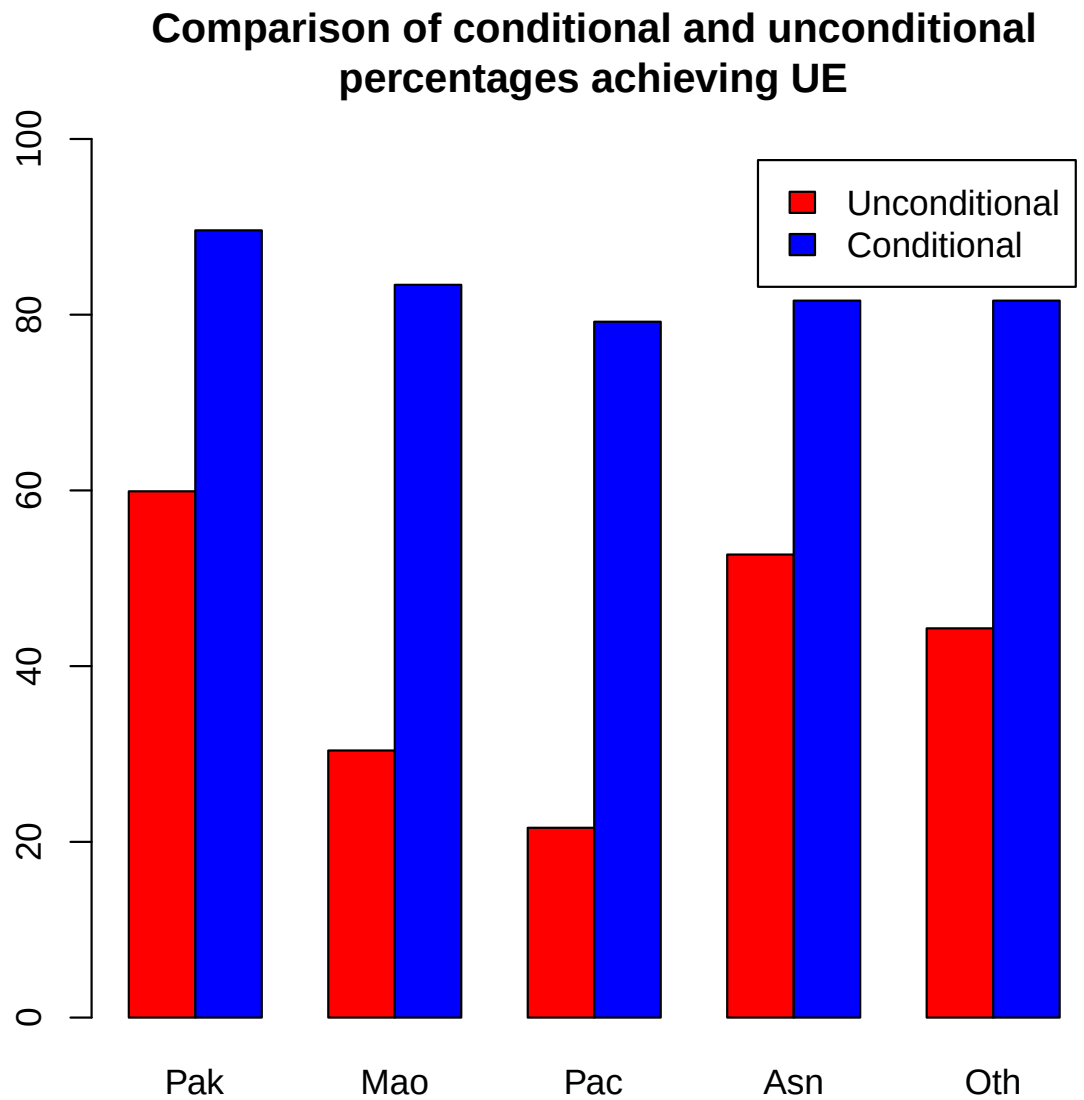
- NZQA UE is based on the following four components:
  - Literacy requirement (8 credits at level 2 or higher in English or Te Reo Māori).
  - Numeracy requirement (14 credits at level 1 or higher in Maths).
  - Approved List subjects requirement (14 credits at Level 3 or higher in *each of* two Approved List subjects).
  - Additional requirement (14 credits at Level 3 or higher in one or two *additional* Approved List subjects or additional "domains".

Conditioning on Component Three

- Component three seems to be the major sticking point.
- It occurred to me to ask: "Suppose we *condition* on the students' having met the component three requirement. What then are the relative probabilities (for the various ethnic groups) of achieving UE?
- The answer was rather striking.
- Of course if you condition on one criterion for success then the probability of success goes up for everyone.
- But the amount by which it goes up differs spectacularly between ethnic groups.

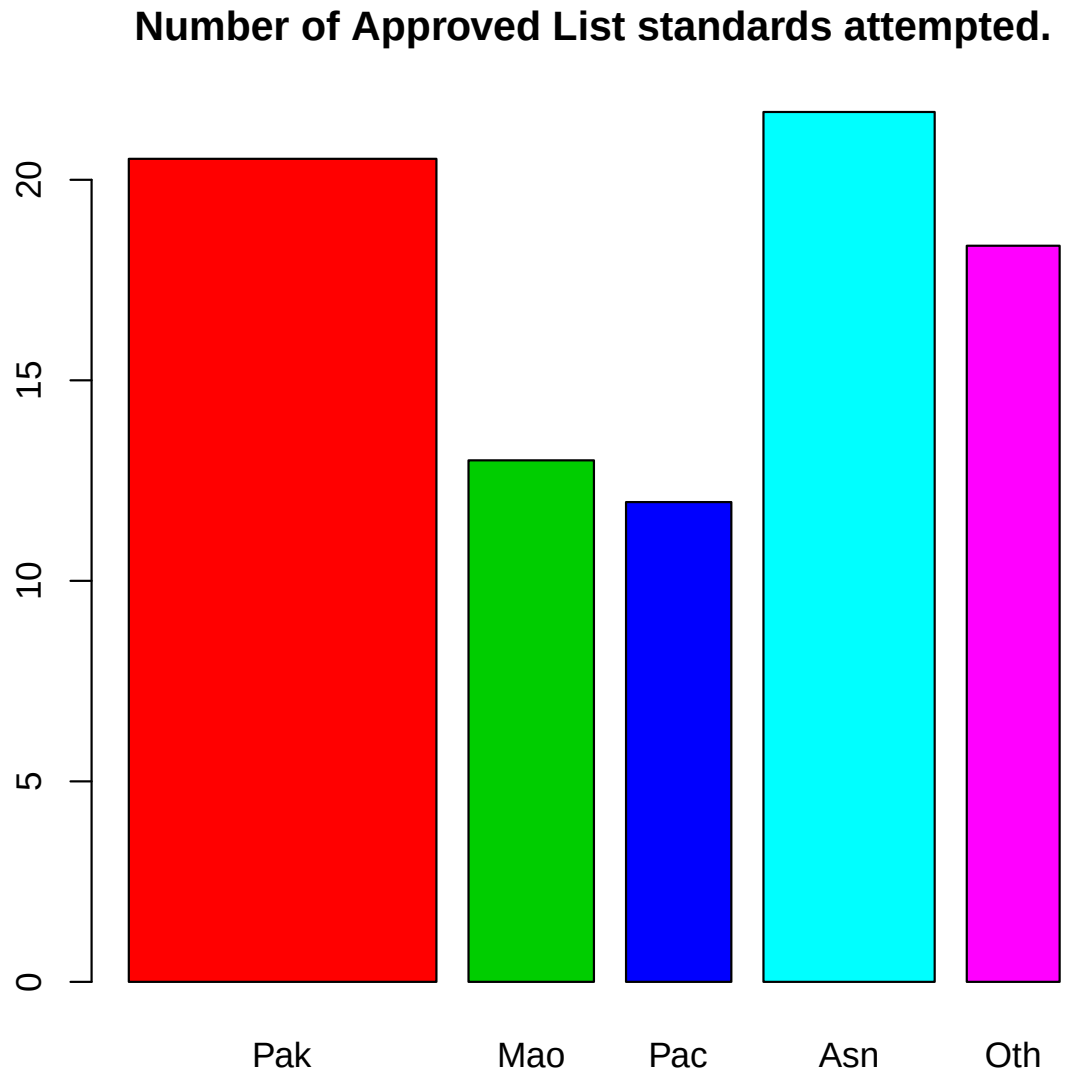

Unconditional percentages achieving UE.
0
20
40
60
80
100
Pak
Mao
Pac
Asn
Oth

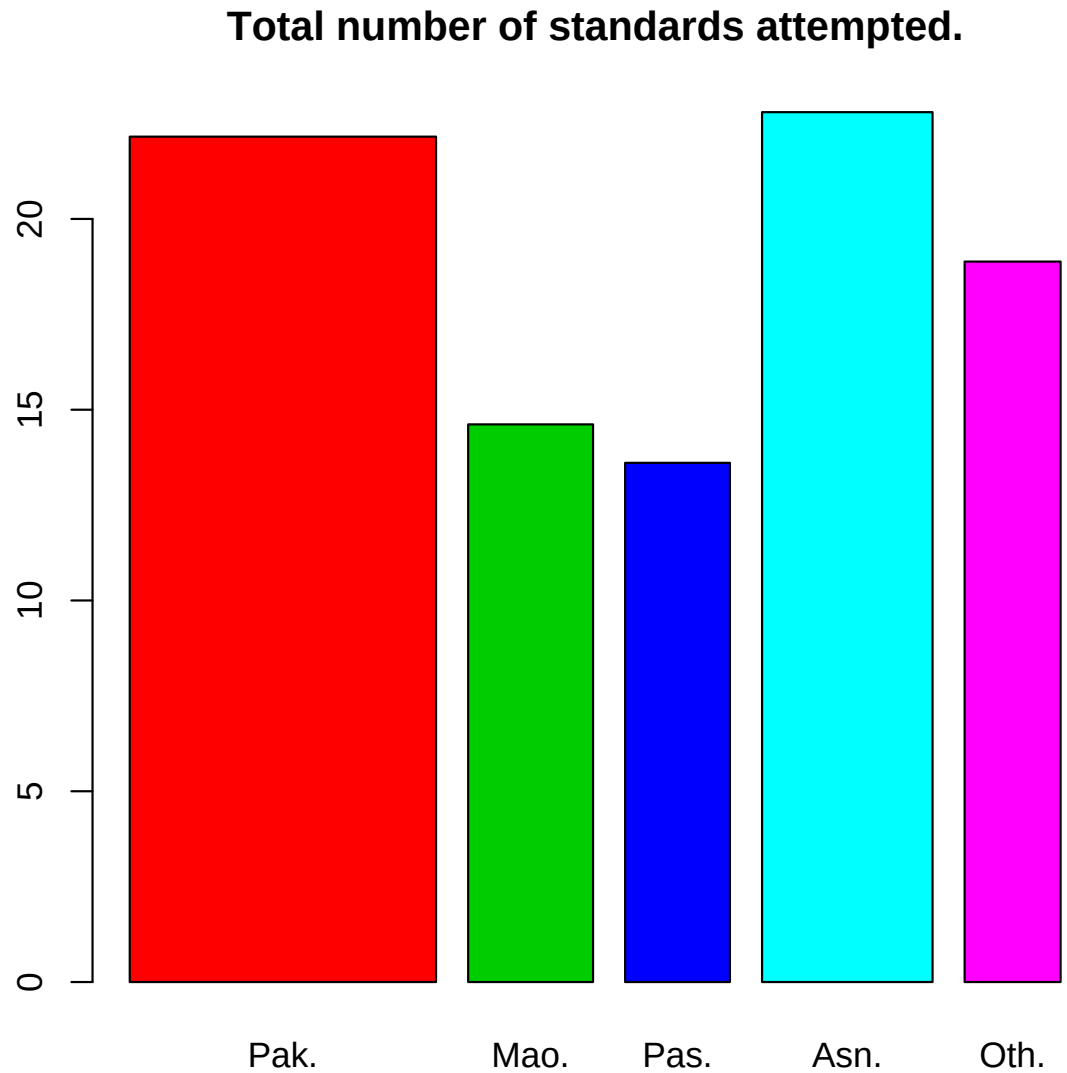

Conditional percentages achieving UE.
100
80
60
40
20
0
Pak
Mao
Pac
Asn
Oth

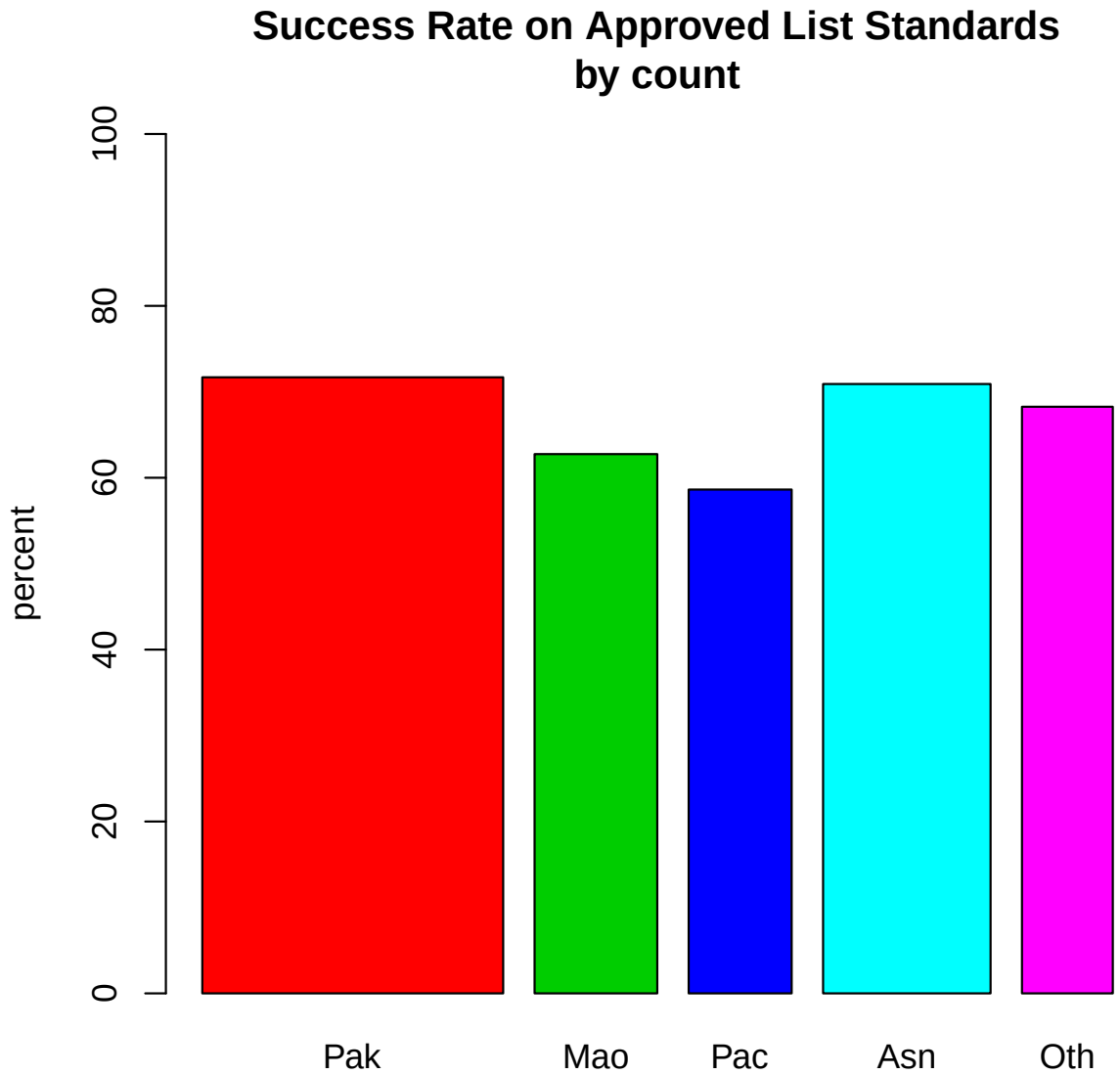

Comparison of conditional and unconditional percentages achieving UE
0
20
40
60
80
100
Unconditional
Conditional
Pak
Mao
Pac
Asn
Oth

Trying to Explain this Phenomenon

- Why does condition three have such a powerful impact?
- I decided to look at the number of Approved List standards *attempted* by students in the various ethnic groups.
- This led to looking at the number of standards of any sort attempted by the various ethnic groups.
- It also led to looking at the various success rates in achieving standards.
- I will show you the corresponding graphs.
- Then I will discuss the implications.


Number of Approved List standards attempted.
0
5
10
15
20
Pak
Mao
Pac
Asn
Oth


Total number of standards attempted.
0
5
10
15
20
Pak.
Mao.
Pas.
Asn.
Oth.


Success Rate on Approved List Standards
by count
percent
0
20
40
60
80
100
Pak
Mao
Pac
Asn
Oth

Standards Attempted — Summary

- Māori and Pacific students attempt far fewer Approved List standards than do Pākehā and Asian students.
- But then they attempt far fewer standards of *any* sort.
- Their success rate is lower — but not enormously lower.
- A reasonable conjecture is that problems arise from the fact that Māori and Pacific students attempt fewer standards.
- The question "Why?" (i.e. why do they attempt fewer standards) cries out for an answer.

Looking at Availability

- It seems plausible that the reason for the "deficit" in the number of standards attempted is (at least in part) a lack of "availability".
- I.e. the question was asked "Might there be a lack of standards for students *to attempt*, at schools attended by the majority of Māori and Pacific students?"

Data Gathering

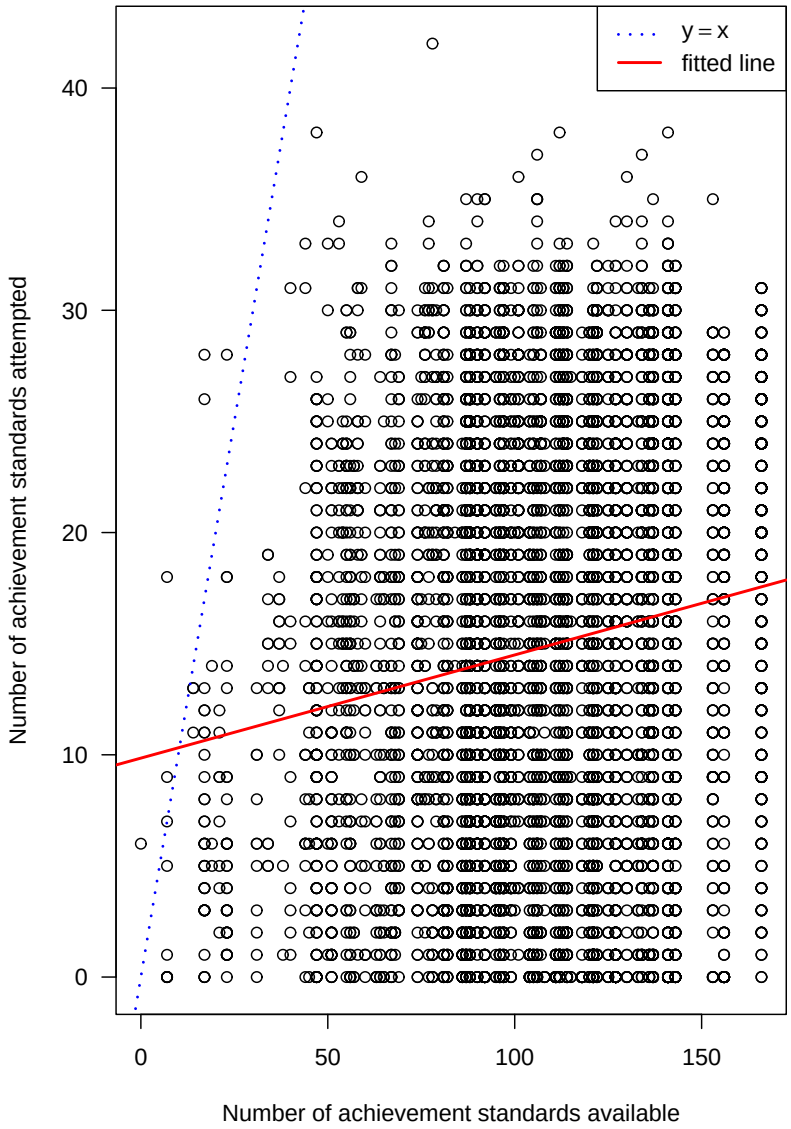
- Requests were sent to all schools in New Zealand which had decile rankings in the 1 to 5 (inclusive) range and which offered at least one year 13 subject.
- Schools were asked to provide us with a list of all NCEA standards, at level 3 and higher, which were available to their students in the 2007 academic year.
- A total of 226 schools were canvassed.
- Of these, 108 responded.

Data Organizing

- The data were summarized in terms of the total number of (level 3 and higher) standards offered by each school.
- They were also summarized by the total number of credits at level 3 and higher.
- These values were also subdivided according to whether the standards were unit or achievement, and whether they were from the Approved List of subjects.
- The resulting data were then merged with the appropriate data from the NCEA 2007 results, on the basis of the "provider code" of the schools in the data set.

Data Analysis

- The best predictor, in any modelling exercise, turned out to be the number of achievement standards available.
- Thus "Approved List" standards, which prompted the investigation, faded from view.
- Note however that predictive power was more or less the same amongst all possible predictors. (The predictors are highly co-linear.)
- The actual analysis: a variety of analyses were conducted, but let's cut to the chase.
- First, it turns out that the number of standards attempted is indeed predicted by the the number of standards available, but not "very strongly".

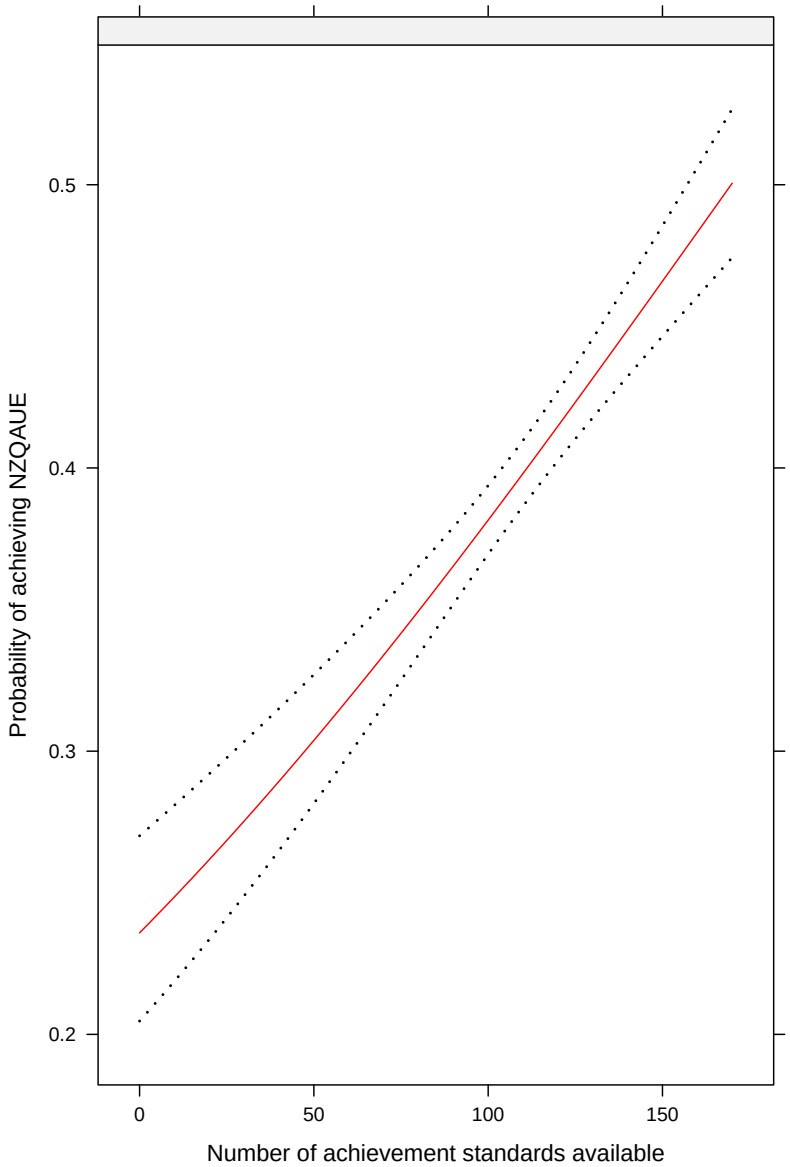

y = x
fitted line
Number of achievement standards attempted
Number of achievement standards available
0
10
20
30
40
0
50
100
150

Data Analysis (Cont'd.)

- What *is predicted strongly* by the number of standards available is the success rate.
- I took a binary response variable

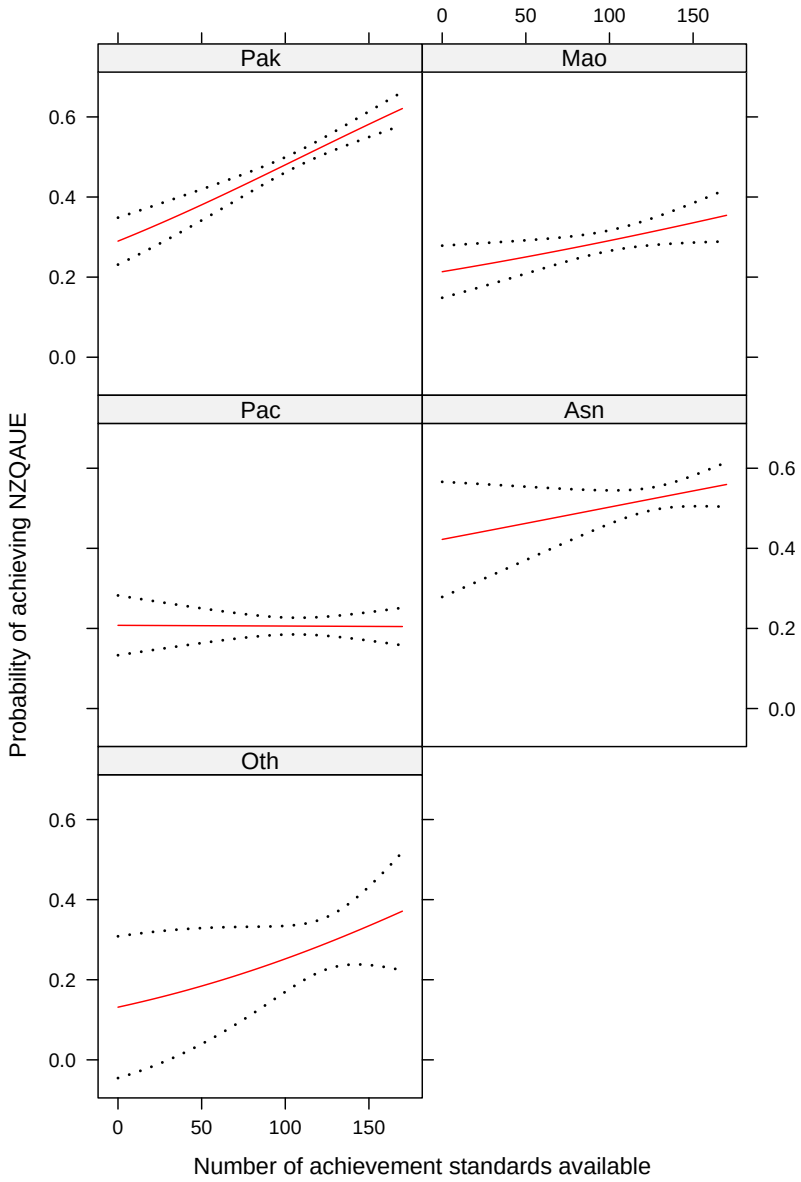
$$Y = \begin{cases} 1 & \text{if the student achieved UE} \\ 0 & \text{otherwise} \end{cases}$$

  and took the predictor to be the number x of achievement standards available at the school attended by the student.
- I fitted a Bernoulli logistic model to these data.


Probability of achieving NZQAUE
0.2
0.3
0.4
0.5
0
50
100
150
Number of achievement standards available

Including Ethnicity in the Model

- The foregoing graph indicates that the probability of success (achieving UE) goes up significantly and strongly with the increasing availability of resources as measured by the number of achievement standards available.
- But since the motivating concern for this study involves ethnicity we'd better look at what impact this factor has on the results.
- I fitted another Bernoulli logistic model with the linear predictor being $\beta_{0,i} + \beta_{1,i} \times x$ where x is the number of achievement standards available and i $(= 1, \ldots, 5)$ indexes ethnicity.
- The results are displayed graphically on the next slide.

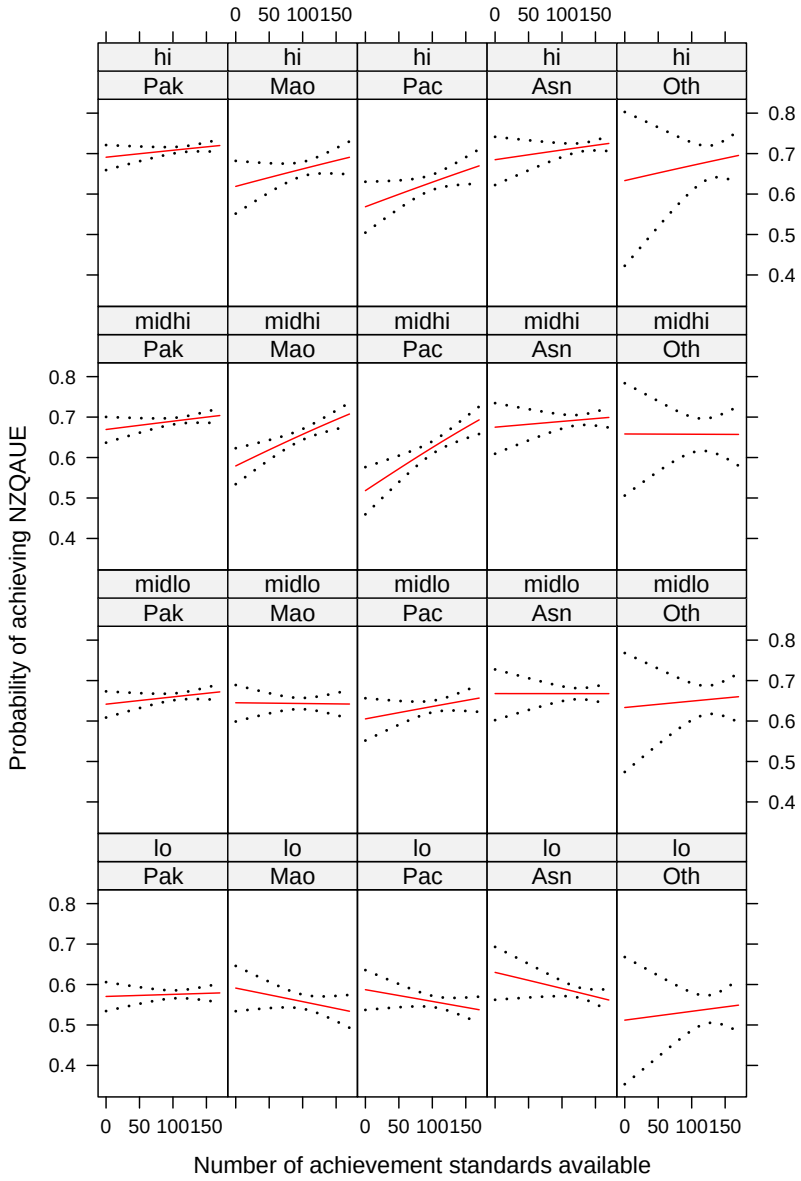

Pak
Mao
Pac
Asn
Oth
0
50
100
150
0.0
0.2
0.4
0.6
Probability of achieving NZQAUE
Number of achievement standards available

Comments

- The positive response to "x" is mostly driven by the Pākehā ethnic group.
- The response of the Māori group is significantly positive, (p-value = 0.02) although the coefficient in the linear predictor is fairly small.
- The responses of the Asian and "Other" groups is not significant, although the point estimates of the response are increasing.
- The really striking feature of the plot is that the Pacific group has an absolutely flat response.
- It would appear that the availability of resources (standards) — or lack thereof — has no effect at all on the Pacific students.
- What's going on?

Further Refinement

- Boaz Shulruf suggested that I try to break down the results further according to "ability" level.
- There is of course no *a priori* measurement of ability level.
- As a surrogate I calculated a pseudo-GPA from the students' NCEA level 3 results.
- This is of course closely related to the binary response variable Y, so we are cheating a bit here.
- However the results are probably informative despite the cheat.
- I subdivided the sample by the quartiles of the NCEA GPA score, and fitted a model with this "ability level" variable as an added predictor.
- The results are displayed graphically on the next slide.


hi Pak
hi Mao
hi Pac
hi Asn
hi Oth
midhi Pak
midhi Mao
midhi Pac
midhi Asn
midhi Oth
midlo Pak
midlo Mao
midlo Pac
midlo Asn
midlo Oth
lo Pak
lo Mao
lo Pac
lo Asn
lo Oth
0 50 100150
0.4
0.5
0.6
0.7
0.8
Probability of achieving NZQAUE
Number of achievement standards available

Implications

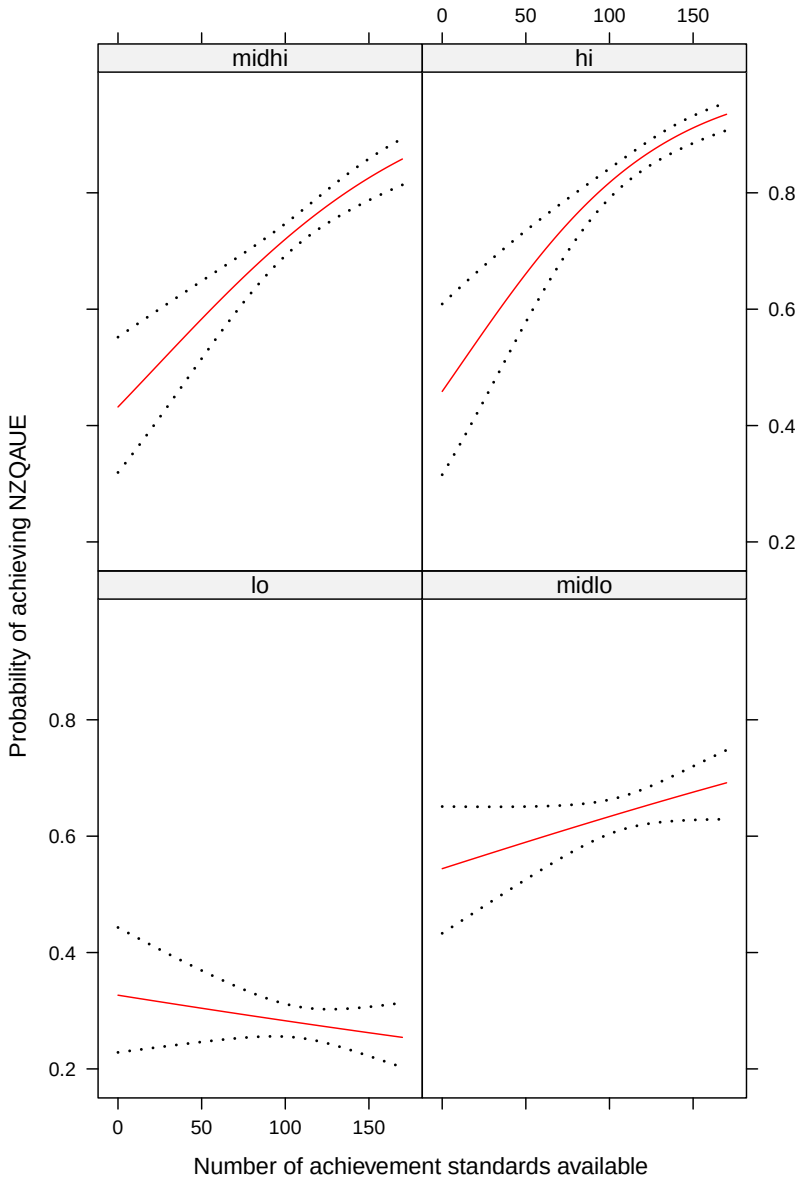
- Of the twenty panels, the predictor "x" is statistically significant only for two: `midhi Mao` and `midhi Pac`.
- What this is saying is that for Māori and Pacific students of moderately high ability, increasing the quantity of resources available will improve their performance.
- This group of students is *precisely* the crucial group!
- It is for these students that we would hope and expect to be able to achieve an improvement.
- The precise policies needed to effect the increase of resources will be tricky to work out — but the message is clear.
- There appears to be substantial evidence that a judicious allocation of new resources could make a difference.

A Criticism — Causation

- It has been suggested — quite rightly — that causation could be running in the opposite direction to that which I am assuming.
- I.e. could it not be the case that academically able students encourage more achievement standards to be offered?
- Rather than having more achievement standards tending to induce students to be academically successful?
- We cannot dismiss this criticism with any certitude. But I think there is evidence to counter it.

Response to the Criticism

- If the criticism is valid, then *given* the academic capability of a student, the number of achievement standards available should make no difference to the student's probability of success.
- However if we use our surrogate measure of academic capability, we find that there is still predictive power in the number of achievement standards available even when academic capability is conditioned on.
- Let's ignore ethnicity and model success rate only by achievement standards available and quartiles of NCEA GPA.
- We find that in the `midlo`, `midhi`, and `hi` quartiles the success rate responds strongly to the number of achievement standards available.


midhi
hi
lo
midlo
0
50
100
150
0.2
0.4
0.6
0.8
Probability of achieving NZQAUE
Number of achievement standards available

Coda — Unexplained Phenomena

- The *mechanism* via which a having a greater number of standards available improves success rate is unclear.
- It appears that the number of standards attempted increases only marginally as the number of standards available increases.
- Hence it seems unlikely that this "direct" mechanism is all there is to it.
- Also, we don't know *why* it is that the Pacific students "flat-line".
- Those negatively sloping responses (non-significant, but the point estimates slope negatively) in the low ability group panels are puzzling.
- The data are hinting (although not telling us forthrightly) that having more resources makes (some) students do worse!
- Why on earth should this be so?