



Accuracy in Student Placement Data

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Abstract

Placement of engineering students at the end of their undergraduate studies is one measure of the success of the educational program. For the measure to be helpful in providing feedback about educational programs, the reported data must present an accurate picture of placement. Accuracy is limited by low response rate, non-response bias, and restrictions on employment eligibility faced by international students. Simulations in this paper demonstrate that, even in the absence of non-response bias, low response rates can lead to inaccurate estimates of the fraction of graduates headed to industry (vs. going to graduate or professional school or pursuing other activities) and inaccurate estimates of job placement. Non-response bias can greatly overestimate job placement rate, even in the setting of otherwise very good response rates, also illustrated by simulation. High enrollment of international students in undergraduate engineering programs coupled with restrictions on their legal right to work in the U.S. can lead to lower overall placement rates that are not necessarily indicative of the quality of the students, education, or placement efforts of that institution. Strategies for increasing response rate and thus eliminating non-response bias as well as a recommendation for separate analysis of the placement of domestic vs. international students are presented.

Introduction

Most engineering schools gather student placement data, which is then used to provide feedback about educational programs, to guide allocation of resources and effort related to placement, and to inform prospective students of what might be in store for them. For placement measures to be helpful for these purposes, the reported data must present an accurate picture of placement. Three significant issues negatively affect the accuracy of these data: low response rate, non-response bias, and restrictions on employment eligibility faced by international students.

Impact of low response rate on placement results

In a limited survey of ten highly ranked U.S. engineering programs where a Ph.D. is the highest degree offered, undergraduate placement survey response rates for the Class of 2011 ranged from 44 to 95%, with a median of 75%. Placement data and response rates were determined from

online postings by the given institution or obtained in response to a personal telephone or e-mail request of the appropriate administrator.

Most engineering programs aim to obtain survey data from an entire graduation cohort rather than sampling a subset of the cohort. Thus, sampling bias, that is non-random selection of which graduates to survey or interview, is generally not an issue. The greater concern is response rate. The American Association for Public Opinion Research (AAPOR) provides six different definitions for response rate¹. Of most relevance to placement reports are the first and second definitions:

$$RR1 = \frac{I}{(I + P) + (R + NC + O) + (UH + UO)}$$

and

$$RR2 = \frac{I + P}{(I + P) + (R + NC + O) + (UH + UO)}$$

where

I = # of complete responses

P = # of partial responses

R = # of refusals to respond

NC = # of non-contacts

O = # of other non-responses

UH + UO = # of unknown eligibility

For purposes of computing accurate placement results, a partial response may be sufficient if placement information is provided even though other survey items such as starting salary or forwarding address may not be provided. Thus, a qualified use of RR2 can be appropriate. As the cohort of graduating students is a clearly defined population, UH + UO is zero in this situation.

As noted above, response rates vary significantly and are often much lower than desired. When response rate goes down, the probability that the survey data will reflect an accurate picture of placement goes down. To illustrate this, a simulation of survey responses was performed. A dataset of 300 graduating students was created with 65% headed to industry, of whom 75% had a

job offer and 25% did not. Thirty percent of the graduating students were headed to graduate or professional schools and 5% had other intentions. Additional assumptions in this simulation included that only eligible students (i.e., degree candidates) were surveyed and that all responses were sufficient to count as complete responses. These simulated data were modeled on the characteristics of our own graduating students and offered the advantages of being de-identified and streamlined to include only relevant data fields.

If 100% of the students completed a survey, then clearly the true industry vs. graduate or professional school vs. other activity breakdown of 65% vs. 30% vs. 5% would be seen. For response rates of 40% to 90%, in steps of 10%, 40 survey trials at each rate were simulated. In each trial at each response rate, the corresponding number of respondents was randomly selected from the 300 member dataset. For example, if the response rate was 60%, 240 students were randomly selected as respondents for each trial. From the respondents, the percent of students headed to industry vs. graduate or professional school vs. other activity as well as the percent of those students headed to industry who were successfully placed were computed. The results for the % of graduates headed to industry are illustrated in Figure 1 and those for % of graduates headed to industry who were successfully placed are illustrated in Figure 2. The collection of points at any one response rate represents a probability density function where the true value of the parameter is most likely to be revealed. As can readily be seen in Figures 1 and 2, increasing the response rate narrows the probability density function, increasing the likelihood that the survey results will represent truth. However, as seen in the figures it is still quite possible, even with a relatively good response rate of 80%, to arrive at a value that differs substantially from the truth.

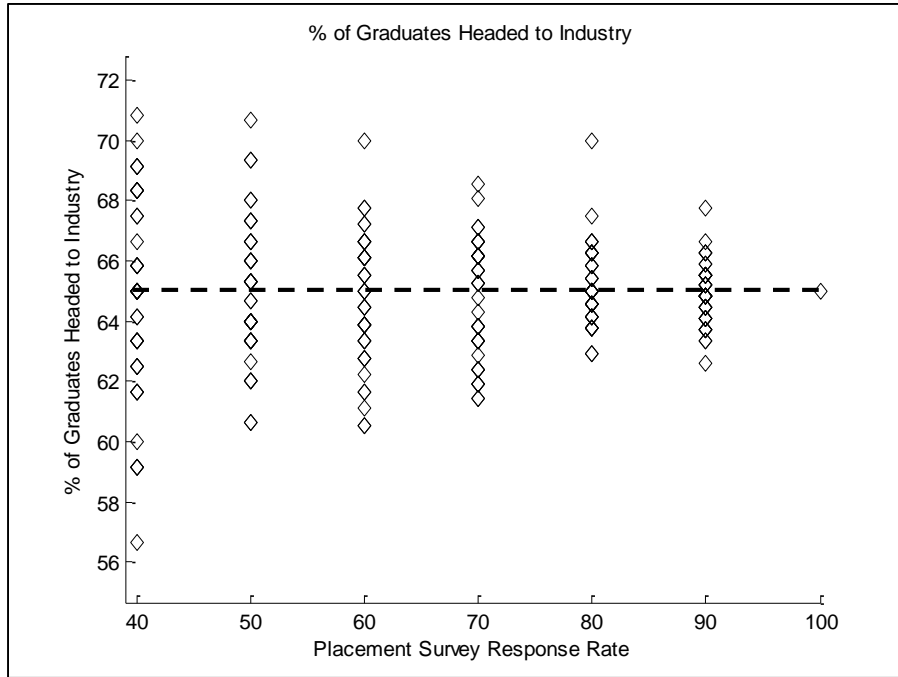


Figure 1. Simulation results for % of graduates headed to industry vs. survey response rate. For each rate, there are points for each of the 40 trials. Many points overlap with the greatest density around the 65% true value, which is indicated by the dashed line.

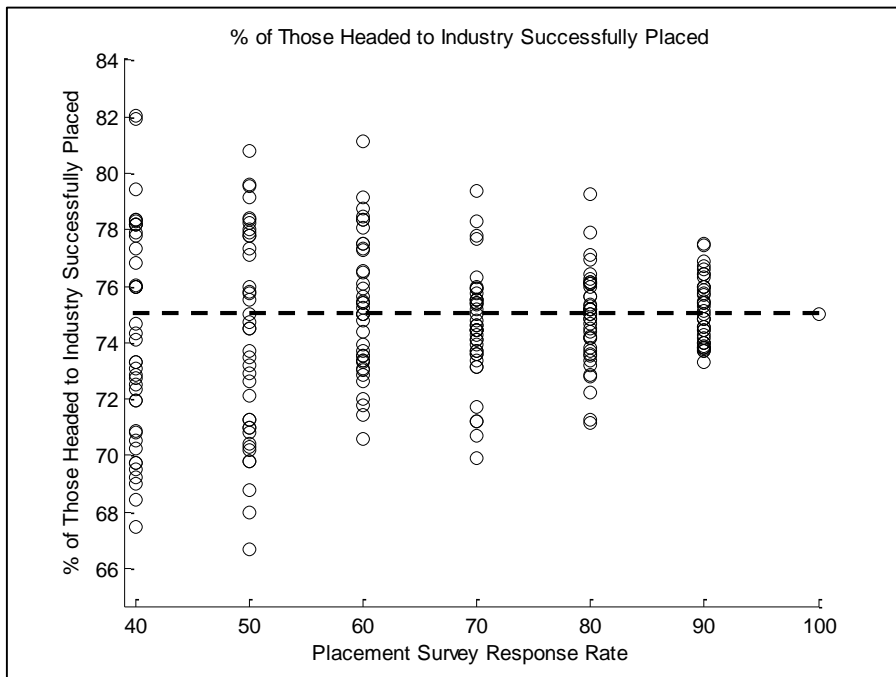


Figure 2. Simulation results for % of graduates successfully placed vs. survey response rate. At each rate, 40 trials were conducted. Increasing the response rate clearly increases the probability of arriving at the true value of 75%, which is indicated by the dashed line.

Failure to complete a survey may result from students not receiving the survey at an opportune time or in a convenient medium, such as a long survey administered online during final examinations. Gender and personality type have also been shown to affect response rates².

Impact of non-response bias on placement results

When non-response bias is present, a low response rate further decreases the likely accuracy of the results. Unfortunately, response rate and non-response bias are often linked³. Non-response bias exists when the likelihood of completing a survey is related to something about the respondent relevant to the survey results. For example, someone with unhealthy behaviors such as smoking or excessive alcohol consumption may be somewhat less likely to respond to a survey about healthy lifestyles than is a person with healthier behaviors⁴. Such non-response bias can lead to serious underreporting of negative outcomes^{4,5}. For example, failure to complete a survey may result from students without placement not wanting to report what they may perceive as failure⁶. Alternatively, the same behaviors that limit the success of some graduates in securing placement, such as missing appointments, losing important papers or electronic links, or chronic procrastination, may likewise limit their completion of a survey. If either is the case, then the non-response bias can be severe, causing a reported placement rate to greatly overestimate the true placement rate.

To illustrate the potential impact of non-response, consider the case where students headed to industry with jobs all respond to a survey while decreasing portions of those headed to industry without jobs respond, as illustrated in Figure 3. If there is 0% non-response bias such that all students from both groups respond, then the placement rate is 75%, which is truth for this simulation. However, if the non-response bias is 50%, students without placement are half as likely to respond as those with placement, resulting in an apparent placement rate of 85%, far above the true value. In the extreme of 100% non-response bias, no students without placement respond and the apparent placement rate is 100%. If in this extreme case, all other students from the simulated data set including those with jobs (75% of 65% of 300), those headed to graduate or professional school (30% of 300) and those with other plans (5% of 300) respond, the overall response rate is a seemingly respectable 84%. This demonstrates how badly non-response bias

can lead to overestimation of placement and how consequently important very high rates of survey completion are.

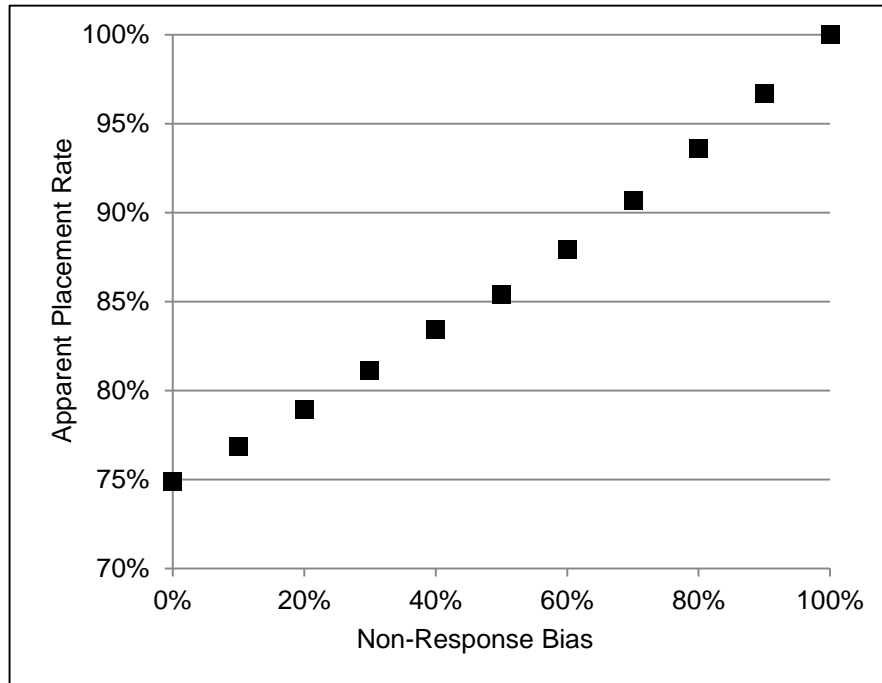


Figure 3. Impact of non-response bias on apparent placement rate in a simulated data set in which 75% of those headed to industry were successfully placed. Non-response bias here is $100\% * (1 - \text{the proportion of students without placement responding} / \text{the proportion of those with placement responding})$. Non-response bias leads to overestimation of placement.

If response rate is not exceptionally high, it is important to make careful estimation of and correction for non-response bias. Methods to do so have been demonstrated^{7,8}, though the effort required to do this well might be better directed toward raising the overall response rate⁹.

Methods to improve response rates

To ensure a high response rate ($\geq 97\%$), several techniques have been implemented at this institution. These techniques have been found to be effective: (1) providing faculty in each major with a list of degree candidates from whom surveys are requested, (2) administering the survey in the month prior to commencement, (3) limiting the survey to one single page, (4) administering the survey on paper in a required senior course or at a special social event for seniors, (5) enlisting staff support to obtain surveys from stragglers, (6) acknowledging degree

programs with 100% response rates, and (7) publishing anonymized summary data each year in a format useful to students and faculty members.

On the whole, faculty members have more interactions with students than do other members of a university community. Thus, it makes sense to have faculty members in each program lead the effort to collect survey data from their graduating students. To ensure that they know exactly who should be surveyed, it is helpful to provide faculty in each major a list of degree candidates. While this list may be the same as the roster of students registered in a required senior course such as capstone design, it is not unusual for discrepancies to exist when a senior plans to spend an extra semester or year as an undergraduate or when a graduating student completed the required senior course in a previous term.

Administering the survey in the month prior to commencement, while the students are still on campus and in contact with their faculty members, obviously allows for increased opportunities for contact and leverage, both increasing response rate. The disadvantage is that some students will not seek or obtain placement until after commencement. Thus, surveys administered six months after commencement, a common practice, will typically always report higher placement than those administered on campus before students leave. However, response rates are typically much lower for post-commencement surveys. As illustrated in this paper, lower response rates can dramatically undermine the accuracy of survey results.

While it may be logical to think that response rate will be higher for a shorter survey, several studies have shown that survey length has little or only a slightly negative impact on response rate¹⁰. What seems to matter more than length is salience, the importance of the survey to the respondent. If a survey wanders off-topic to subjects not important to the respondent, response rate goes down with increasing length¹⁰. Also, there is some evidence of a threshold effect where response rate is lower for surveys over a certain length¹¹. So, while a survey longer than one page is not necessarily a barrier to high response rates, it is important to keep the questions focused and relevant. The practical matters of affording classroom time to complete the surveys and keeping track of multiple pages motivate use of a shorter survey. The survey used at this institution is included as an appendix to this paper.

Administering the survey on paper in a required senior course such as capstone design or at a special social event for seniors helps improve response rates. This is akin to the interview approach in opinion surveys yielding higher response rates than mailed surveys¹². Obviously, a student is more likely to respond to a survey if in the presence of a faculty member giving them the survey.

It is likely despite all above efforts that a few students will not initially respond. These can be clearly identified when returned surveys are compared against the list of degree candidates given to the faculty member in charge. At this stage, it is helpful to enlist the aid of a teaching assistant or staff member to individually contact non-respondents. Increased follow up efforts increase the likelihood of response¹³.

Just as incentives offered to prospective respondents can increase response rates^{13, 14}, so can incentives for the faculty members administering the survey lead to higher response rates. At this institution, simple acknowledgement of those degree programs with 100% response rates in the foreword to the summary report and in a meeting of department chairs motivates those with high response rates to continue their efforts in the following year. Embarrassment of those programs with lower response rates motivates increased efforts in the following year to improve response rate.

Finally, for the last two years, an anonymized summary of the survey results has been published online and advertised to current students. Students have thus been able to access information valuable to them such as what companies have just recently employed graduates from their major(s), what graduate and professional schools have admitted students from their major(s), mean and median salaries, and graduate school stipends. A more detailed but still anonymized report is distributed to faculty. Having access to these reports demonstrates to participants that their privacy will be respected and that their participation will provide valuable information to their peers.

These efforts have resulted in a response rate of 97% for the past two graduating classes and thus a very high probability that the survey results reflect placement accurately.

Impact of international enrollment on placement data

Another issue specifically affecting employment placement results is the proportion of the undergraduate population that is international. In the U.S., international students earn 6.5% of engineering bachelor degrees awarded¹⁵. However, international students on F-1 visas have restrictions on their right to work in the U.S.A. Degree recipients with an F-1 visa may work in the U.S.A. for up to 12 months under the “Optional Practical Training (OPT)” provision¹⁶. If their degrees and work are in science, technology, engineering, or mathematics (STEM), OPT may be extended an additional 17 months¹⁶. To retain an international employee beyond this 29 month period, the employer must successfully petition for an H-1B visa on behalf of the individual. Given the extra paperwork involved, the congressionally mandated annual cap on the number of H-1B visas that can be granted, and the consequent risk of deportation of a trained employee, many U.S. employers refuse to hire international students. Additionally, many international students wish to return to their home country to seek employment after graduation. Either circumstance, employer refusal to hire international graduates or the graduates’ desires to delay searching for employment until after returning home lowers the number graduates that can be successfully placed by graduation.

To illustrate the potential impact on employment placement results, assume that 75% of domestic (U.S. citizen or permanent resident) graduating engineers garner a job offer by commencement. If there are no international students, then the overall placement rate is also 75%. If 6.5% of the students are international and thus much less likely to have employment by commencement, the overall placement rate could drop from 75% to 70%, assuming no change in the placement of domestic students. At this institution, international students make up 17% of the graduates, well above the national average of 6.5%. If none of the international students have jobs by graduation while 75% of the domestic students do, the overall placement rate is 62%. Thus, high enrollment of international students in undergraduate engineering programs can lead to lower overall placement rates that are not necessarily indicative of the quality of the students, education, or

placement efforts of that institution. The obvious solution is to separately report the placement of domestic and international students.

Conclusion

Low response rates, non-response bias, and the impact of a large international student population each can very negatively affect the accuracy and usefulness of an educational program's placement data. A graduation survey with a response rate so high that it essentially eliminates non-response bias and uncertainty in results combined with separate analyses for students with and without an unrestricted right to work in the U.S. yield results that are more useful to an educational institution. Accurate results can reveal opportunities for increased synergies with key industrial partners and graduate/professional programs and for improving educational programs. Such a survey also facilitates legitimate comparisons between different institutions.

**Appendix: VANDERBILT UNIVERSITY SCHOOL OF ENGINEERING
SURVEY OF FUTURE PLANS, May [year] Graduates**

Name _____ Major(s) _____

ID _____

In the first column below, please indicate the ONE item that you intend as your primary activity this fall. In the second column, indicate any other activities that you plan to do this fall.

Primary Activity **Secondary Activity**
(Mark only one) (Mark all that apply)

		Employment, full-time paid, non-military
		Employment, part-time paid, non-military
		Full-time military service
		Graduate or professional school, full-time
		Graduate or professional school, part-time
		Additional undergraduate coursework
		Full-time volunteer activity (e.g., Peace Corps)
		Traveling
		Undecided
		Other Activity, specify: _____

If you selected **employment, full-time** as your primary activity, which of the following BEST describes your current employment plans?

- Accepted a position*
- Considering one or more specific offers* from _____
- Offered a position by _____ but declined*; still searching for preferred position
- Currently searching for a position or waiting for an offer
- Will begin searching for a position after graduation

If you have accepted a position, please provide the following:

Name of Employer _____ Position Title _____

Location (City, State) _____

Annual Salary \$ _____ Bonus \$ _____

*Did you receive any offers from employers that recruited through the [*institutional career center*] via listings in [*institutional online service*], info sessions, career fairs, or on-campus interviews? yes no

If you selected **graduate or professional school, full OR part time** as your primary activity, which of the following BEST describes your current plans?

- Admitted, planning to attend _____ (institution)
- Considering admission offer(s) from _____ (institution(s))
- Wait listed
- Applied but no offers of admission received to date
- Have not applied

If you have accepted an offer of admission, please indicate institution above and provide the following:

Name of degree program or department _____

Will you be a research assistant? _____ teaching assistant? _____ Stipend \$ _____

Degree(s) sought (circle all that apply): MS, ME, MBA, MS/PhD, MD/PhD, PhD, JD, MD, _____

Address and email for future contact:

e-mail: _____

Bibliography

- ¹ Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys, Revised 2011. The American Association for Public Opinion Research (AAPOR). http://www.aapor.org/AM/Template.cfm?Section=Standard_Definitions2&Template=/CM/ContentDisplay.cfm&ContentID=3156 , accessed 2 January 2014.
- ² Porter S.R. & Whitcomb M.E. (2005). Non-Response in Student Surveys: The Role of Demographics, Engagement and Personality. *Research in Higher Education*, vol. 46(2), 127-152.
- ³ Groves, R.M. & Peytcheva, E. (2008). The Impact of Nonresponse Rates on Nonresponse Bias: A Meta-Analysis *The Public Opinion Quarterly*, vol. 72(2), 167-189.
- ⁴ Hill, A., Roberts, J., Ewings, P., & Gunnell, D. (1997). Non-response bias in a lifestyle survey. *Journal of Public Health*, 19(2), 203-207.
- ⁵ Hoeymans, N., Feskens, E. J., Van den bos, G.A.M., & Kromhout, D. (1998). Non-response bias in a study of cardiovascular diseases, functional status and self-rated health among elderly men. *Age and Ageing*, 27(1), 35-40.
- ⁶ Riphahn, R. T., & Serfling, O. (2005). Item non-response on income and wealth questions. *Empirical Economics*, 30(2), 521-538.
- ⁷ Armstrong, J.S. & Overton, T. S., Estimating Nonresponse Bias in Mail Surveys. (1977). *Journal of Marketing Research*, vol. 14, 396-402. Available at SSRN: <http://ssrn.com/abstract=659542>
- ⁸ Barclay, S., Todd, C., Finlay, I., Grande, G., & Wyatt, P. (2002). Not another questionnaire! Maximizing the response rate, predicting non-response and assessing non-response bias in postal questionnaire studies of GPs. *Family Practice*, 19(1), 105-111.
- ⁹ Peytchev, A., Baxter, R.K. & Carley-Baxter, L.R. (2009). Not All Survey Effort Is Equal: Reduction of Nonresponse Bias and Nonresponse Error. *The Public Opinion Quarterly* , Vol. 73(4), 785-806.
- ¹⁰ Heberlein, T.A. & Baumgartner, R.. Factors Affecting Response Rates to Mailed Questionnaires: A Quantitative Analysis of the Published Literature. (1978). *American Sociological Review* , vol. 43(4), 447-462.
- ¹¹ Jepson, C., Asch, D. A., Hershey, J. C., & Ubel, P. A. (2005). In a mailed physician survey, questionnaire length had a threshold effect on response rate. *Journal of clinical epidemiology*, 58(1), 103-105.
- ¹² Goyder, J. (1985). Face-to-face interviews and mailed questionnaires: The net difference in response rate. *Public Opinion Quarterly*, 49(2), 234-252.
- ¹³ James, J. M., & Bolstein, R. (1990). The effect of monetary incentives and follow-up mailings on the response rate and response quality in mail surveys. *Public Opinion Quarterly*, 54(3), 346-361.
- ¹⁴ Willimack,D.K., Schuman, H., Pennell, B.-E., & Lepkowski, J.M. (1995). Effects of a Prepaid Nonmonetary Incentive on Response Rates and Response Quality in a Face-to-Face Survey. *The Public Opinion Quarterly* , Vol. 59(1), 78-92.
- ¹⁵ Engineering and Technology Degrees 2011, Engineering Workforce Commission of the American Association of Engineering Societies, Inc., Reston VA.
- ¹⁶ U.S. Citizenship and Immigration Services, <http://www.uscis.gov/archive/archive-news/questions-and-answers-extension-optional-practical-training-program-qualified-students>, accessed 23 December 2013.