

## **Annex A: Interpreting multi-level models**

Multi-variate analyses contained in this report are conducted within a multi-level framework. This Annex summarises, in non-technical language, how such models are interpreted.

The data from the National Student Survey are inherently multi-level in structure with students nested within institutions. This nesting means that two, otherwise identical students based at the same institution are likely to be more similar in their responses to the survey than two otherwise identical students at two different institutions<sup>1</sup>. The models used in this report model this structure by explicitly setting students within institutions. The models have two core elements: the 'fixed' part, which estimates the impact of the student, course and institutional characteristics on the responses to the survey, and the 'random' part which estimates the degree of variation between institutions. This 'random' part also allows for the estimation of institutional residuals.

### **Interpreting the 'fixed' part**

The coefficients presented in the Annexes are entirely analogous to those obtained from standard regression models. As each of the characteristics in the models are modelled using a dummy (binary) variable, each coefficient can be interpreted as the change in the score associated with being a member of the specified student group as compared with the reference group. For example, in Annex C, Table C.1, the coefficient for females in 2006 is 0.034. This means that, all other things being equal, we would expect a female student to have a score on the Teaching and Learning scale that is 0.034 higher than a male student.

To assess if these coefficients are statistically significant, they are compared to their standard errors. To be statistically significant at the 99% confidence level the coefficient must be 2.57 times greater than its standard error. Again, looking at the coefficient for females in 2006 in Annex C, Table C.1 the coefficient value is 0.034 with a standard error of 0.004. Thus, the coefficient is 8.5 times the size of the standard error and so we can conclude that females were significantly more positive about Teaching and Learning in 2006 than were male students, holding all other effects constant.

Note: The models in Annex L are logistic multi-level models because they deal with binary outcome variables. In this case statistical significance is assessed in the same way but the coefficients are no longer on a linear scale and so interpretation of the coefficients is slightly different. In these cases the coefficient represents the change in the log-odds of the outcome variable; however as with the earlier scales the larger the coefficient the greater is the impact of the variable on the outcome measure.

### **Interpreting the 'random' part: institutional residuals**

Within any kind of statistical model there is a 'residual' term where the predicted scores vary from the actual scores for a particular student. In the multi-level framework we can divide this residual term into the part associated with the student

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<sup>1</sup> In statistical terms this means that the error terms from a standard regression model are likely to be correlated within institutions and therefore estimates from standard regression models may be biased. Further details of the technical aspects of Multi-level models can be found in Goldstein, H. (2003) *Multi-level Statistical Models*.

and a part associated with the institution which is common to all students at that institution. The institutional residual which can be calculated in this way is a measure of the extent to which the scores at that institution vary from those we expect given the student, course and institutional characteristics taken into account in the model. As with coefficients in the fixed part of the model, these institutional residuals must be assessed for statistical significance. Again, this is measured at the 99% confidence level by comparing the residual with 2.57 times its associated standard error. However, to assess the significance of residuals we create a confidence interval based on this calculation and compare against zero.

The 99% confidence interval is calculated as the residual  $\pm 2.57(\text{standard error})$ . If this confidence interval crosses zero then the institutional residual is not significantly different from zero, in other words there is no statistically significant difference between the score for the institution and the score we would expect for the institution based on its student and course profile and institutional characteristics (included in the models).

This is illustrated in Figure A.1. Each point in Figure A.1 represents an institutional residual shown with a bar to illustrate the 99% confidence interval. As can be seen from the figure, the majority of institutions have confidence intervals which cross the zero line, and are therefore not statistically significant from the scores we would expect for that institution. The circles highlight a small group of institutions at each end of the chart. Those in the bottom left are institutions whose confidence interval lies entirely below zero, indicating that these institutions had scores significantly lower than those we would expect from their student, course and institutional characteristics. The circle at the top right highlights a group of institutions whose confidence interval lies entirely above the zero line; this group of institutions had scores significantly higher than we would expect from their student, course and institutional characteristics.

Figure A.1: Institutional residuals + 99% confidence interval, Teaching and Learning Scale, 2006

