Report on the Validity and Reliability of the Dutch Residency Educational Climate Test (D-RECT)

As deployed by the Medical Council in the National Trainee Experience Survey 2014

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Background:

The Dutch Residency Educational Climate Test (D-RECT) is a 50 item scale for the evaluation of postgraduate clinical learning environments. The Medical Council used this scale as part of its Your Training Counts National Trainee Experience Survey 2014. The scale has been developed and validated for use in the Netherlands by Boor et al(1). Boor et al developed their scale on the basis of previous qualitative work on postgraduate clinical learning environments in the Netherlands (2,3) and a subsequent modified Delphi method with Dutch experts was used to refine items included. Boor et al then went on to test the construct validity of the instrument, using both Exploratory and Confirmatory Factor Analysis(1). D-RECT was shown to measure clinical learning environment along 11 distinct dimensions, or subscales, and to do so in a manner that is consistently reproducible. Generalisability testing was also undertaken to examine the number of respondents at various levels, department, hospital site etc. required to generate a reliable measure.

Transferring the D-RECT instrument to a new setting, that of Irish Postgraduate Medical Education and Training, requires re-assessment of the construct validity and reliability data referred to above. D-RECT has not, as yet, been validated for use outside the Netherlands. Whilst the features of good clinical learning environments are likely to be very similar internationally, it is possible that some of the individual items within D-RECT will be interpreted differently in the Irish context, due to differences in how training is conducted and in how healthcare is delivered. The terminology used in some of the items in D-RECT has been slightly adjusted in recognition of this by the Medical Council. Demonstration of validity and reliability of the instrument in the Irish context is essential for quality assurance of the learning environment data generated by the Your Training Counts survey.

Objective:

The project team were commissioned by the Medical Council to describe the reliability and validity evidence for the use of D-RECT in the Irish context, based on responses to the Your Training Counts National Trainee Experience Survey 2014.

Team Expertise:

The project team has a track record of excellence in Medical Education research. Dr. Bennett, project lead for this proposal from UCC, has published work using the DRECT to survey trainees of all levels under the Royal College of Physicians of Ireland(4). As such she has familiarity with the instrument and its factor structure. The team has extensive experience of learning environment tools in the undergraduate setting (5,6) and has published validity data on one such tool, the Dundee Ready Educational Environment Measure (7). The psychometric skills of the team are also evidenced in the development of a tool to measure undergraduate medical student stress, the Medical Student Stress Profile (8).

What is reliability?

D-RECT requires respondents to interpret 50 statements (or items) and indicate a level of agreement with each statement. The reliability of an instrument, such as D-RECT, refers to its ability to produce consistent scores under consistent conditions. An alpha coefficient (α), which can range from 0 to 1,

is used to indicate the degree to which individual items are consistent across the test. An alpha coefficient of 1 means total consistency: in other words, you would expect that if the clinical learning environment is good, that the individual items in a test to measure the clinical learning environment would be consistently be highly rated. We would not expect them to be totally consistent however, as within the clinical learning environment there are separate elements, or factors, which may vary. In considering acceptable reliability, the purpose of data collection and the need for precision for that purpose are taken into account. Reliability is a relative rather than absolute concept; however, an alpha coefficient >0.8 is generally considered to be a more acceptable measure of reliability.

What is validity?

The validity of a questionnaire refers to evidence that it is measuring what it claims to measure. Validity evidence can be derived from multiple sources(9):

- Evidence based on the content of the questionnaire;
- Evidence based on responses to the questionnaire items;
- Evidence based on the structure of the questionnaire; its reliability and analysis of the relationships between the responses to the individual items in the instrument.

Reliability and Validity of D-RECT in the Your Training Counts Survey

1572 responses to D-RECT were provided to the research team by the Medical Council. 596 or the responses were incomplete, due either to missing items (n=83), items deemed by trainees to be non-applicable to their current post (n= 495), or a combination of both (n=18).

General Applicability of the Items

When the D-RECT is used across different training contexts not all of the items are equally applicable. This means that in some case items will need to be skipped or unanswered. This was the case with the majority of 'missing items' in the YTC dataset; they were deemed 'not applicable'. A statistical response to this situation is to treat such items as missing and then apply imputation for missing data. The problem with this approach is that the items are not, in fact, missing but are not applicable. The 'missing' nature of such items is not random but systematic. In this case we follow the strategy of replacing 'missing' values with the mean of the 'non- missing' values. This means generating the scale score as the mean of the valid responses. In this way each respondent is directly comparable with others even though they may have answered fewer items. This procedure is predicated on the assumption that the items have all been sampled from the same domain of items and that they can be demonstrated to be highly consistent with each other. We will return to this issue later.

Reliability

The full set of D-RECT responses (50 questions) are used to examine the overall clinical learning environment. The responses to D-RECT collected in the Your Training Counts survey were shown to be a very reliable single measure, or total rating of satisfaction, in relation to overall clinical learning environment (α=0.96).

D-RECT has been designed to measure 11 distinct dimensions of the clinical learning environment using subscales, each comprising 2-8 questions. These are shown in Table 1 below along with an alpha co-efficient for each. The reliability of the D-RECT subscales is lower than the total scale (α coefficient range 0.67-0.92). The majority of these subscales have acceptable reliability ($\alpha > 0.8$) but some subscales are less reliable. Specifically these are *Work adapted to competence* (α=0.78), *Supervision* (α=0.75), and *Peer collaboration* (α=0.67). The reliability of these subscales is toward the lower end of acceptable reliability, although they are broadly consistent with the Dutch findings.

This subscale structure serves largely to demonstrate the construct validity of the general satisfaction domain and is less helpful in diagnostic terms. Nevertheless the psychometric properties appear quite persuasive. The total score appears psychometrically robust with an alpha coefficient of 0.97. The main finding here supports the notion that the items are drawn from a highly consistent item domain. Our tactic of using the mean of valid responses for scoring the scales is supported.

Subscale	N of Items	Raw Mean	Standard Deviation	Item Mean	Alpha
Supervision	3	10.92	2.69	3.64	0.75
Coaching and Assessment	8	22.66	7.31	3.22	0.92
Feedback	3	7.91	3.18	2.66	0.83
Teamwork	4	15.33	3.13	3.83	0.82
Peer Collaboration	3	11.60	2.17	3.88	0.67
Professional Relations	3	9.70	2.62	3.25	0.81
Work Adapted to Competence	4	13.61	3.39	3.41	0.78
Consultants Role	8	27.94	5.34	3.52	0.83
Formal Education	4	15.38	3.21	3.84	0.83
Role of Speciality Tutor	6	20.16	5.11	3.38	0.86
Patient Sign Out	4	13.19	3.45	3.30	0.81
Total	50	170.83	31.72	3.44	0.96

Table 1.

Spearman-Brown Prophecy Formula

Because we advocate a scoring method in which the mean of valid item responses are taken as the scale scores, a further analysis is indicated to show how many non applicable items are acceptable for scoring each scale. We used the Spearman-Brown Prophecy formula to estimate the number of items required to produce a score reliability of 0.80. It is clear that for the smaller subscales non applicable items will render the scale scores unreliable. In fact some subscales do not reach this criterion and should instead have items added. The ratio column in Table 2 (below) describes the proportion by which the item numbers may be modified to ascertain an alpha of 0.80. Ratios over 1 indicate scales in which more items are required to meet this criterion. The column Opt shows the rounded-up number of items required to meet the alpha of 0.80 while the column Tol indicates the tolerance for non-applicable items. A minus number in this column indicates that more items not less are required. This clearly shows the inadvisability of relying upon the 11 subscale scores as many of the scales are inadequately furnished with items. Nevertheless, the total score is very tolerant of non-applicable items.

Subscale	N of Items	S-B Ratio	Opt	Tol
Supervision	3	1.333	4	-1
Coaching and Assessment	8	0.348	3	5
Feedback	3	0.819	3	0
Teamwork	4	0.878	4	0
Peer Collaboration	3	1.970	6	-3
Professional Relations	3	0.938	3	0
Work Adapted to Competence	4	1.128	5	-1
Consultants Role	8	0.819	7	1
Formal Education	4	0.819	4	0
Role of Speciality Tutor	6	0.651	4	2
Patient Sign Out	4	0.597	3	1
Total	50	0.167	9	41

Table 2.

Validity

The validity evidence relating to the content of D-RECT is found firstly in the manner of its original development. The items used are derived from expert opinion, previous research and theories of how people learn in workplaces. This theoretical foundation suggests that the D-RECT has content validity beyond its original context of use. Content validity for the Irish context is also supported by the prior use of D-RECT for measurement of clinical learning environment, with a subset of the trainee group surveyed in Your Training Counts (4). Furthermore, the consultation exercise undertaken by the Medical Council in relation to selection of the D-RECT instrument and the expert bench-marking process, strongly support the validity of the content of D-RECT for use in Ireland.

D-RECT scores were shown to be generalisable from groups defined by specialty, postgraduate training body, training network/ area (site) and stage of training to the wider population within that group. The generalisability of scores in further sub-categories, defined by combinations of these variables, for example postgraduate training body and stage of training, are less robust. A bootstrapping exercise was conducted to determine that, where a minimum of thirty respondents is achieved in each group, the generalisability score is more acceptable (g index >0.8) and it is possible to generalise from these groups with confidence (see Appendix A). While it is possible to use D-RECT scores from smaller groups of respondents, a more cautious approach is required in generalising to the wider population within that group.

Factor Analysis

Our first analysis was to carry out a Multiple Group Factor Analysis (MGFA) on all data with complete data. This is a restricted or 'confirmatory' factor analysis in which the 50 items are constrained to conform to the a-priori 11 factor model. A least squares procedure was used (10). This is a non-iterative procedure for fitting observed data to an expected pattern. Fitting such models is often problematic because the coefficients most often used are either sample size dependent or heuristic estimates. We have elected to uses a very simple fitting index proposed by Fleming (11) which has

the advantage of allowing us to gauge the fit to the model for each item and each factor separately as well providing a general model fit parameter. Fleming's index is essentially a signal to noise ration and ranges between 0 and 1. It may be interpreted in much the same way as a reliability coefficient, a higher value indicating better fit. An additional advantage of this method is the fact that a very large number of competing models can be tested alongside the theoretical target model. We generated 10,000 randomly generated models and estimated the fit for each. The target fit is then compared to the randomly generated model. Experience suggests that the distribution of random fit indices is essentially normal although there is no statistical guarantee of this. As a rough guide a standardised deviation of the target fit from the mean random fit provides a method for judging whether the target model has been confirmed. In addition, it is expected that the target model should show a better fit than any of the random models before we can assert that the model is confirmed.

The factor analysis is presented in Table 3. The full factor pattern for the 11-factor model is presented. The overall fit of the model is 0.92. The mean fit for 10,000 models is 0.74 with a standard deviation of 0.0167. This renders a z score of 10.78, placing the target fit over 10 standard deviations above the mean fit, no random model exceeded the target value. Trainees in both countries understand the questionnaire similarly and respond in similar patterns. D-RECT is measuring a stable construct in both Ireland and the Netherlands. Therefore it is an instrument with good construct validity.

TABLE 3
Multiple Group 'Confirmatory' Factor Analysis of the 50 Items of the D-RECT

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Simplicity
1	0.46	0.02	-0.03	-0.00	0.01	-0.05	0.09	-0.00	0.06	-0.03	0.00	0.91
2	0.57	-0.01	-0.02	-0.06	-0.00	0.00	-0.05	0.00	-0.00	0.00	0.03	0.97
3	0.52	-0.01	0.05	0.06	-0.01	0.04	-0.04	-0.00	-0.05	0.03	-0.03	0.93
4	0.05	0.43	-0.09	0.03	0.03	-0.01	-0.03	0.02	-0.07	-0.04	-0.00	0.88
5	-0.03	0.44	-0.04	0.01	-0.00	0.01	0.02	0.00	0.01	-0.00	-0.02	0.97
6	0.01	0.38	-0.05	0.00	0.04	0.02	0.00	0.02	0.10	-0.08	-0.01	0.85
7	0.00	0.40	0.04	-0.05	-0.02	0.01	0.00	-0.01	-0.03	0.01	0.05	0.93
8	-0.01	0.43	0.00	-0.01	0.00	-0.01	-0.04	0.02	-0.01	0.07	-0.01	0.95
9	0.02	0.39	0.01	0.01	-0.01	-0.00	0.01	-0.02	0.02	0.01	0.01	0.97
10	-0.03	0.35	0.11	-0.00	-0.05	-0.00	0.03	-0.02	-0.05	0.04	-0.03	0.83
11	-0.03	0.42	0.01	0.01	0.00	-0.01	-0.00	-0.00	0.02	-0.02	0.01	0.97
12	0.01	0.21	0.33	-0.02	-0.02	0.01	0.00	0.01	-0.03	0.02	0.01	0.68
13	-0.00	-0.11	0.76	0.01	0.01	0.00	-0.00	0.00	0.01	-0.00	0.00	0.97
14	-0.00	-0.10	0.77	0.01	0.01	-0.01	0.00	-0.01	0.02	-0.02	-0.01	0.97
15	0.03	0.01	-0.01	0.60	0.01	0.04	0.02	0.04	-0.00	-0.02	-0.03	0.98
16	-0.03	-0.02	0.03	0.73	-0.06	-0.04	0.03	-0.00	-0.01	0.01	-0.01	0.98
17	-0.01	-0.00	0.02	0.68	-0.04	0.00	-0.06	0.00	0.01	0.02	-0.02	0.98
18	0.01	0.01	-0.04	0.56	0.08	0.00	0.00	-0.04	0.00	-0.01	0.06	0.95
19	-0.02	0.00	-0.00	0.06	0.74	0.02	-0.01	-0.00	-0.00	-0.00	-0.00	0.99
20	-0.03	0.03	-0.00	0.01	0.75	-0.00	-0.00	0.00	-0.03	-0.04	0.02	0.99
21	0.05	-0.04	0.01	-0.08	0.63	-0.01	0.01	0.00	0.03	0.04	-0.01	0.96
22	0.03	-0.04	0.02	-0.02	-0.00	0.70	0.00	-0.02	-0.00	0.00	0.00	0.99
23	-0.03	0.06	-0.01	0.00	0.01	0.66	-0.01	-0.01	0.00	-0.00	0.02	0.98
24	0.00	-0.01	-0.00	0.02	-0.01	0.67	0.01	0.03	-0.00	0.00	-0.02	0.99
25	0.06	0.02	-0.05	-0.01	0.04	0.00	0.48	0.00	0.03	-0.07	0.00	0.93
26	0.00	0.03	-0.04	0.07	-0.05	0.00	0.53	-0.01	-0.03	-0.00	-0.01	0.95
27	-0.03	-0.02	0.00	-0.05	-0.00	-0.02	0.49	0.01	-0.01	0.08	-0.00	0.95
28	-0.02	-0.04	0.08	0.00	0.01	0.01	0.45	0.00	0.00	-0.00	0.01	0.94
29	0.02	-0.12	0.04	0.05	-0.01	0.02	0.06	0.40	-0.23	0.12	-0.02	0.63
30	-0.07	0.02	0.04	0.01	-0.01	-0.01	0.01	0.48	-0.28	0.10	-0.04	0.69
31	-0.08	0.07	-0.01	0.02	0.00	-0.03	-0.04	0.46	-0.14	0.04	-0.02	0.83
32	0.01	0.03	0.00	0.01	0.04	0.00	-0.00	0.35	0.02	-0.08	-0.01	0.92
33	0.07	0.05	-0.05	-0.05	0.02	-0.04	-0.03	0.30	0.14	-0.04	0.01	0.69
34	0.04	0.02	-0.03	-0.04	0.03	-0.08	0.00	0.33	0.16	-0.07	0.03	0.69
35	-0.03	-0.08	0.04	-0.02	-0.04	0.19	-0.00	0.25	0.11	0.01	-0.01	0.50
36	0.03	-0.01	-0.05	0.01	-0.02	-0.04	0.00	0.28	0.22	-0.08	0.06	0.54
37	0.03	-0.01	-0.04	0.01	0.05	-0.02	0.01	0.11	0.41	-0.09	0.04	0.85
38	-0.01	0.04	-0.04	-0.01	-0.01	0.05	-0.05	0.03	0.46	-0.01	0.04	0.93
39	0.00	-0.02	0.03	0.00	0.01	-0.02	0.00	-0.08	0.63	0.04	-0.03	0.96
40	-0.02	-0.00	0.05	-0.01	-0.05	-0.00	0.03	-0.06	0.57	0.06	-0.05	0.94
41	-0.02	-0.03	-0.02	-0.00	0.02	-0.01	0.06	0.01	0.04	0.46	-0.12	0.89
42	-0.02	-0.01	-0.04	0.00	-0.00	0.01	0.01	0.00	0.00	0.54	-0.13	0.93
43	0.03	-0.03	-0.00	0.01	-0.01	0.01	0.05	-0.01	-0.03	0.50	-0.05	0.96
44	-0.03	0.07	-0.06	-0.01	0.03	-0.00	-0.03	0.01	0.08	0.40	-0.01	0.88
45	0.03	0.01	0.08	0.01	-0.03	-0.04	-0.03	-0.00	-0.06	0.32	0.18	0.66
46	0.01	-0.00	0.06	-0.01	-0.00	0.02	-0.05	-0.02	-0.03	0.36	0.13	0.82
47	0.03	-0.05	-0.01	-0.00	-0.00	-0.00	-0.05	0.01	-0.04	0.23	0.35	0.66
48	-0.00	0.01	0.04	0.01	-0.03	-0.00	0.03	-0.00	-0.03	-0.01	0.48	0.97
49	0.03	0.02	-0.05	0.00	0.02	-0.03	0.01	-0.01	0.05	-0.15	0.54	0.90
50	-0.06	0.00	0.02	-0.01	0.01	0.04	0.00	0.00	0.02	-0.06	0.48	0.95
Factor Fit	0.93	0.90	0.93	0.97	0.97	0.95	0.94	0.96	0.77	0.86	0.87	0.92

Factor Correlation Matrix

I	1.00										
II	0.74	1.00									
III	0.53	0.68	1.00								
IV	0.40	0.45	0.32	1.00							
V	0.26	0.22	0.15	0.37	1.00						
VI	0.43	0.46	0.36	0.36	0.31	1.00					
VII	0.60	0.63	0.49	0.51	0.37	0.45	1.00				
VIII	0.62	0.68	0.48	0.53	0.32	0.56	0.68	1.00			
IX	0.57	0.61	0.43	0.46	0.28	0.48	0.54	0.74	1.00		
X	0.56	0.62	0.50	0.46	0.35	0.47	0.68	0.67	0.56	1.00	
XI	0.58	0.68	0.56	0.39	0.29	0.43	0.60	0.63	0.54	0.75	1.00

Z=10.78

Summary

In summary, the content and constructs of D-RECT have good validity. The total scale and the majority of subscales are reliable. These findings mean that the total D-RECT score measures clinical learning environment in the Irish context, with a high level of precision. Most of subscale scores also measure their targets, the distinct dimensions of the clinical learning environment, with acceptable precision. Some subscales do so with less precision than we would like, and caution is required in their interpretation. The small number of items in some of the subscales is an important contributor to this lack of precision. Generalising from respondent groups of at least 30 trainees, to the wider population of trainees, is valid. More detailed analysis, at subscale level and with smaller groups of respondents should be interpreted more cautiously. Overall, this makes D-RECT a useful way to examine the clinical learning environment in Ireland, especially when using total score from larger numbers of respondents. Care should be taken when interpreting results based on small groups of trainees, especially at subscale level.

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Appendix A: G study results

Generalisability testing was conducted across the various groups within the study population. The G coefficients are generally supportive. A standard analysis of variance was also conducted, to demonstrate the differences between groups for each grouping variable. Sometimes there will be a statistically significant difference between groups and yet the G coefficient is still quite high. This indicates that the qualitative meaning of the measure is equivalent across groups although the quantity of satisfaction with training may vary. The following tables describe these results.

Descriptive Statistics for Site

Site	Mean	Std. Deviation	N
Dublin Midlands	3.3084	.70189	138
Dublin North East	3.3526	.65866	265
GP Practice	3.7361	.53815	204
Mental Health Services	3.8227	.68003	107
Midwest	3.4826	.60193	73
Paediatrics	3.3678	.55229	79
South/South West	3.3450	.62647	238
West/North West	3.3153	.64579	194
Dublin East	3.3360	.61889	247
Other	3.8252	.58298	27
Total	3.4370	.65141	1572

Oneway ANOVA

$F = 20.802$ $p<0.001$ $\eta^2 = 0.096$

The F ratio is highly significant indicating group differences. You can see that the Mental Health Services, Other and GP Practice groups had the highest satisfaction with training. The lowest were Dublin Midlands and West/Northwest. However the effect size of 0.096 is quite small and as the mean scores reflect the 1-5 ordinal scale you can see that they are all above 3. So everyone is happy just some are happier than others.

G-Analysis (Items by Site)

	MS	DF	Variance Component
Site	110.61	9	1.83
Item	95.18	49	9.44
interaction	2.09	441	0.14
Residual(m)	19.28		
Residual(i)	0.73		

Absolute G = 0.76

This G-Analysis shows the computational steps in estimating G. Here the G is 0.76. This is pretty good although generalisability perfectionists tend to suggest 0.80 as the target to aim for.

Descriptive Statistics for Stage of Training

Stage of Training	Mean	Std. Deviation	N
Basic Specialist Training Programme	3.3697	.64794	406
G.P. Training Programme	3.5044	.63872	357
Higher Specialist Training Programme	3.6256	.59403	430
Intern Training Programme	3.0281	.60912	238
Registrar Training Programme	3.6391	.60843	84
Run-through (basic and higher) Specialist TP	3.4573	.58801	54
Other	3.9165	.39139	3
Total	3.4370	.65141	1572

Oneway ANOVA

F = 27.073 p<0.001 η^2 = 0.094

G-Analysis (Items by Stage of Training)

	MS	DF	Variance Component

Stage of Training	267.79	6		4.98
Item	7.07	49		0.91
interaction	3.33	294		0.37
Residual(m)	18.59			
Residual(i)	0.72			

Absolute G = 0.96

Descriptive Statistics for GP Training

GP Training	Mean	Std. Deviation	N
Not in GP Training	3.3957	.65317	1360
In GP Training	3.7018	.57458	212
Total	3.4370	.65141	1572

Oneway ANOVA

F = 41.528 p<0.001 η^2 = 0.026

G-Analysis (Items by GP Training)

	MS	DF	Variance Component
Main	92.38	1	1.45
Item	41.82	49	20.54
Interaction	5.69	49	2.48
Residual(m)	20.01		
Residual(i)	0.73		

Absolute G = 0.63

Descriptive Statistics for Speciality

Speciality (Block)	Mean	Std. Deviation	N
Anaesthesia	3.5317	.54634	121
Emergency Medicine	3.2480	.69785	65
General Practice	3.7018	.57458	212
Surgery	3.2491	.67580	250
Medicine	3.3103	.63551	455
Obstetrics & Gynaecology	3.2374	.62153	81
Occupational Medicine	4.0127	.30001	4
Ophthalmology	3.4326	.41604	15
Paediatrics	3.3853	.58278	115
Pathology	3.4578	.71001	54
Psychiatry	3.8615	.59212	124
Public Health Medicine	4.0055	.48327	4
Radiology	3.7516	.57386	50
Other	3.3225	.52274	22
Total	3.4370	.65141	1572

One Way ANOVA

F = 13.650 p<0.001 ω^2 = 0.102

G-Analysis (Item by Speciality)

MS DF Variance Component

Main	113.67	12	1.89
Item	29.50	49	2.27
interaction	2.75	588	0.21
Residual(m)	18.95		
Residual(i)	0.71		

Absolute G = 0.82

Descriptive Statistics for Training Body

OVERSEE	Mean	Std. Deviation	N
Intern Training Network	3.0863	.56841	165
Royal College of Physicians in Ireland	3.4226	.63077	332
Royal College of Surgeons in Ireland	3.5090	.62726	145
The College of Anaesthetists of Ireland	3.5970	.53558	87
The College of Psychiatry of Ireland	3.8822	.64920	54
The Faculty of Radiologists	3.8457	.53351	7
The Irish College of General Practitioners	3.3884	.59846	170
The Irish College of Ophthalmologists	3.4089	.63743	9
Other	3.4457	.73916	7
Total	3.4167	.63434	976

One Way ANOVA

F = 11.921 p<0.001 η^2 = 0.090

G-Analysis (Item by Training Body)

	MS	DF	Variance Component
Training Body	220.12	8	4.03

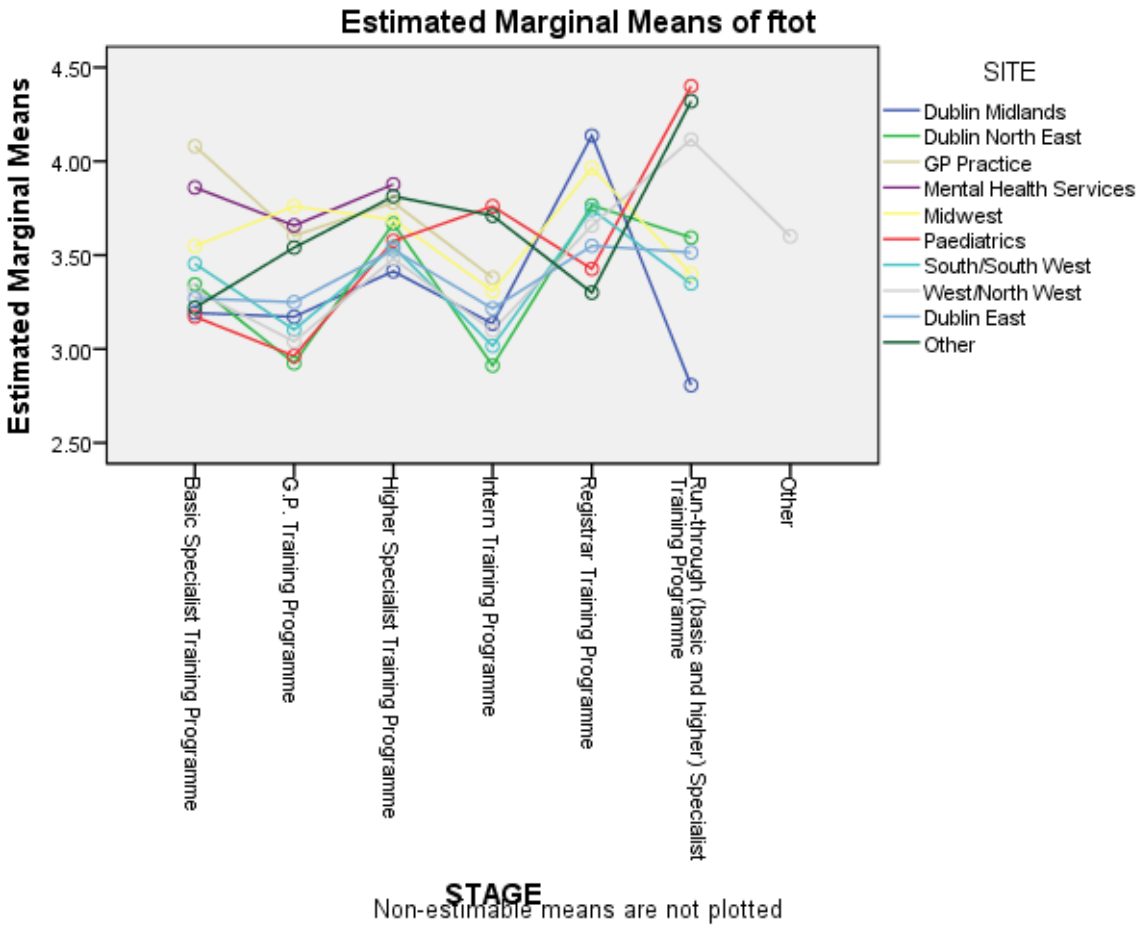
Item	31.41	49	3.41
Interaction	3.54	392	0.31
Residual(m)	18.465		
Residual(i)	0.715		

Absolute G = 0.90

Analysis of Site by Stage

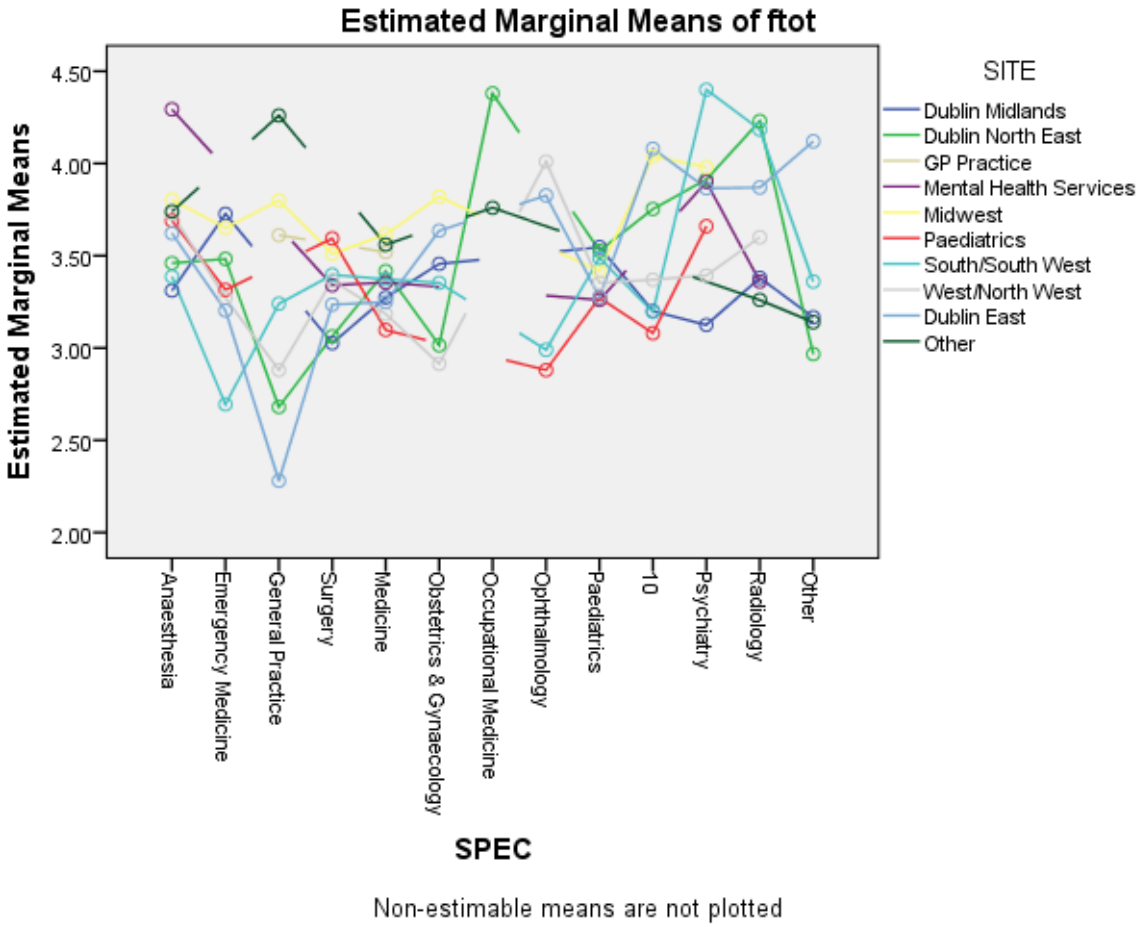
Site	1.56	9	4.10**	0.30	0.25
Stage	1.52	6	4.02**	0.08	0.16
Site by Stage	0.44.	40	1.16	0.05	0.06
Residual	0.38				

G=0.54

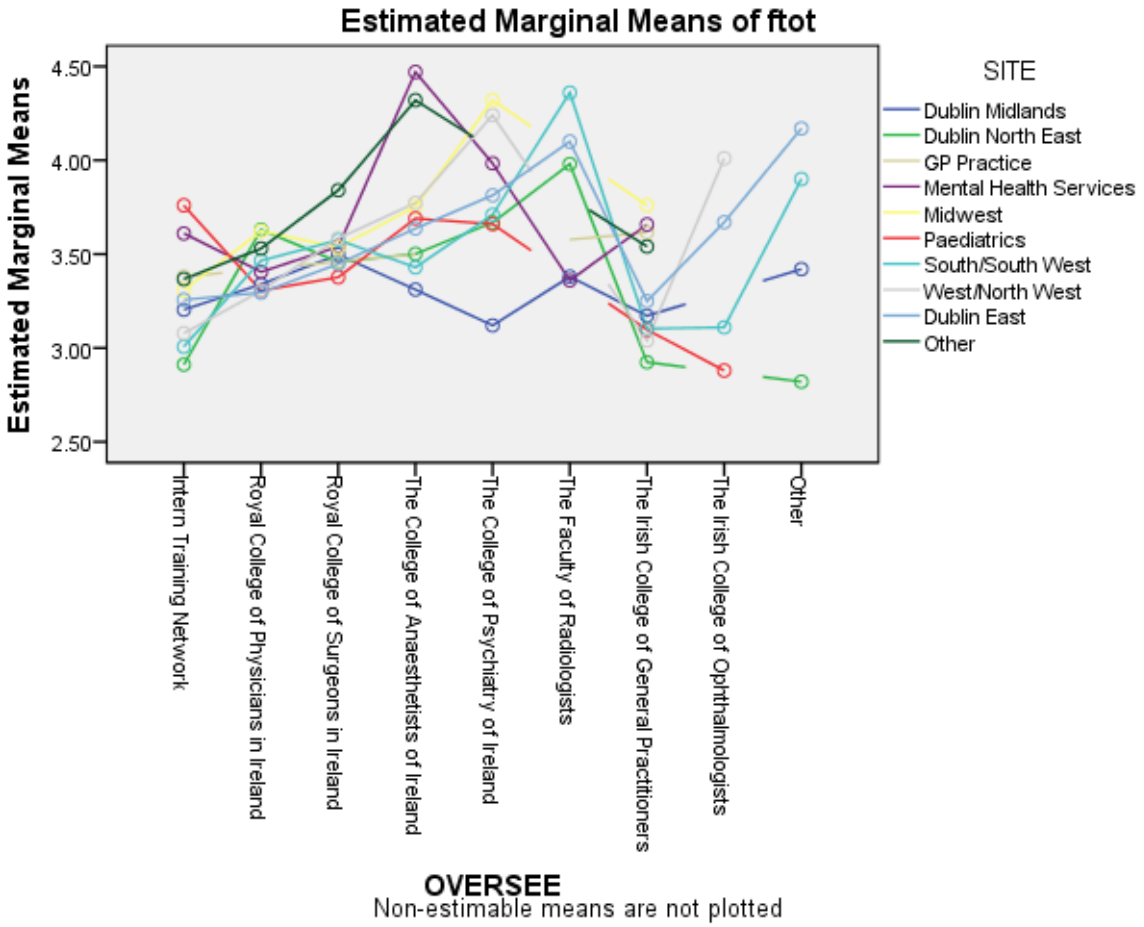

Estimated Marginal Means of ftot
Estimated Marginal Means
4.50
4.00
3.50
3.00
2.50
SITE
Dublin Midlands
Dublin North East
GP Practice
Mental Health Services
Midwest
Paediatrics
South/South West
West/North West
Dublin East
Other
Basic Specialist Training Programme
G.P. Training Programme
Higher Specialist Training Programme
Intern Training Programme
Registrar Training Programme
Run-through (basic and higher) Specialist Training Programme
Other
STAGE
Non-estimable means are not plotted

Site	0.42	9	1.06	0.03
Spec	0.79	12	2.01	0.07
Site x Spec	0.47	66	1.19	0.08
Residual	0.39			

G= 0.89



Oversee	1.21	8	3.21	0.09		0.113	
Site	0.75	9	1.99	0.05		0.074	g = 0.81
Oversee by Site 0.46	51	1.22	0.07		0.080		
Residual	0.38						



Bootstrapping Method: Numbers needed for a reliable response

There is a general view that the sample in each group should be as large as possible to make for reliable results. The question of what the minimum acceptable number has been addressed using a bootstrapping method, in which the data is sampled with replacement to generate varying subsample sizes. Since this is dependent on the individuals selected a program was written to randomly sample from the existing data generating 100 different results for each sample size. The average G-coefficient was then taken as representative of that particular sample size. Sample sizes varied between 3 and 100.The smaller the sample the smaller the G as expected. As the sample size increases so does the generalisability. These analyses were carried out for all the independent variables and the consistent finding was that around 30 cases in each group was required to rely upon a good generalisability (set at 0.8).

The bootstrap output is shown here:

3	0.477143579274882
4	0.451393907097954
5	0.449443635305183
6	0.48009245089408
7	0.501850252025502
8	0.509705920331037
9	0.508059212501517
10	0.538873300674487
11	0.566428343502949
12	0.595405156392312
13	0.600246426029656
14	0.594203417126117
15	0.62063788179498
16	0.670484998887938
17	0.673872203541281
18	0.704409840477895
19	0.713775837457267
20	0.704327905908406
21	0.727671921718245
22	0.736813497148803
23	0.74562025282408
24	0.76392590397937
25	0.768176934422792
26	0.755093963832333
27	0.777232576056231
28	0.780679623380783
29	0.792821408125703
30	0.786554470927521
31	0.801743724377137
32	0.795811225503417
33	0.813841147241551
34	0.811737990511755
35	0.820859666998235
36	0.830579878796614
37	0.838711432506402
38	0.838154512695195
39	0.825664864267199
40	0.848188191874693
41	0.837597594024188
42	0.849229595564261
43	0.849764348360232
44	0.860150432122486
45	0.860586317019843
46	0.859850062629013
47	0.857263101342257
48	0.869618689595987
49	0.869776380782416
50	0.873584351107635
51	0.875859014477095
52	0.879475076011732
53	0.877053554190818
54	0.878505385137734
55	0.885452850543588
56	0.89088036584469
57	0.886192624978841
58	0.884034001165725
59	0.895907916830121
60	0.890825254025574
61	0.896952273104257
62	0.894200933298018
63	0.901988800663089
64	0.904539968582975
65	0.902558730798732
66	0.903802678553113
67	0.905406362483408
68	0.906402112530308
69	0.90718459327102
70	0.90876839185738
71	0.908519951260131
72	0.908990623338058
73	0.90795399674005
74	0.913590679666964
75	0.914428380493964
76	0.914950559626167
77	0.917446177374705
78	0.917293916168616
79	0.917832234406549
80	0.919849630283958
81	0.921695859659142
82	0.920647933746945
83	0.922295119750958
84	0.92089535068693
85	0.924945470700249
86	0.9252970616929
87	0.927918304898143
88	0.925583646666029
89	0.92788119770048
90	0.927156095285643
91	0.928981701600359
92	0.926185625590314
93	0.931774980511517
94	0.92934083184441
95	0.932376769054623
96	0.933332041375124
97	0.934915552749925
98	0.93258820023887
99	0.93090672929336
100	0.936009855767013
3	0.456509545140115
4	0.466104621191062
5	0.447785684106585

6	0.499410496895318
7	0.522789079789981
8	0.53611042940431
9	0.547851096520742
10	0.579522571089779
11	0.591174590532119
12	0.636381174709654
13	0.647031239938375
14	0.646384370265218
15	0.663462777667734
16	0.68365782229689
17	0.686344947259199
18	0.719753335443724
19	0.729286143911743
20	0.748410172069782
21	0.760193555315095
22	0.752161611145549
23	0.777471792836581
24	0.784263174497664
25	0.793605141455819
26	0.805326517822043
27	0.796313230400335
28	0.817034720885904
29	0.806696708788677
30	0.818477629218421
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33	0.835470124194342
34	0.845362242559355
35	0.845303439857218
36	0.850921331206763
37	0.851901049604684
38	0.850873270462334
39	0.859007770314312
40	0.858952161542044
41	0.865705811385845
42	0.863495768041341
43	0.870390571145213
44	0.87003582135997
45	0.873846176144972
46	0.882892585400974
47	0.876936099544784
48	0.880745271228065
49	0.886277986572866
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51	0.885351022942324
52	0.892158378512648
53	0.891427613319576
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55	0.898985283434277
56	0.896747158994303
57	0.902337303459437
58	0.901593749198362
59	0.902030114009783
60	0.904378663960302
61	0.909939627745615
62	0.907532804876944
63	0.905188161632251
64	0.909500494801744
65	0.912541893036011
66	0.909850420756846
67	0.915090436283529
68	0.915366678133373
69	0.9176372560444
70	0.915774427268251
71	0.916417834441692
72	0.919430572046225
73	0.919816598041226
74	0.919466944257013
75	0.920578235462884
76	0.923223452558027
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78	0.928106575858018
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62	0.826487257690683
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36	0.609858683040467
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52	0.636035033429764
53	0.6287121147766
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55	0.621510350218027
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57	0.634181611112851
58	0.680131574646545
59	0.667086253625654
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61	0.682944989972342
62	0.66733527043783
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64	0.704176327907704
65	0.664314676377711
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68	0.681040009321103
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70	0.647083231170976
71	0.67588514597925
72	0.677100980383013
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78	0.736272613723521
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91	0.709983446429669
92	0.698606088968194
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96	0.697566054309552
97	0.739607303493875
98	0.707777655406998
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