



Summary of the North Carolina
Editions 2 and 3 Concordance
Biology

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General Summary and Notes

The creation of the concordance between Edition 3 and Edition 2 Biology scale scores was conducted by Dr. Joshua Goodman from July 21st to July 23rd 2013, with oversight and review by Dr. Alan Nicewander.

The Biology test was administered in both paper/pencil and online formats, with three operational forms (A, B, & C for paper; M, N, & O for online) associated with each mode of delivery. The operational forms can be considered paired (A/M, B/N, and C/O) across modes where each form-pair, (with few exceptions) contain the same operational and concordance linking items. However, the form-pairs were calibrated in a manner that allowed corresponding items that perform differently across modes to have unique parameter values. As a result of the number of items and the magnitude of the differences in item parameters across item-pairs, Pacific Metrics completed a separate concordance table for each mode. The end results of the two concordances was very similar and a decision to aggregate across modes was made in collaboration with NCDPI psychometricians.

General notes

- All item parameter inputs (including operational Edition 3 parameters, concordance linking items on Edition 3, and concordance linking items on the Edition 2 metric) to the concordance process were provided by NCDPI.
- All Edition 3 parameters were calibrated on the logistic metric (scaling constant $D=1.0$).
- The Edition 2 parameters were calibrated assuming a normal distribution ($D=1.7$).
- Scaling Edition 3 parameters to the Edition 2 bank scale was performed at the form level in order to avoid the assumption that the population receiving each form was equivalent.
- EAP scores and the associated scale scores were created using the entire pool of operational items.
- Item 10235, which appeared on forms C and O was removed from the concordance process at NCDPI's request.

Creation of Edition 3 EAP Estimates and Scale Scores

Using the entire set of Edition 3 operational item parameters, an EAP score and an associated Edition 3 scale score was estimated for each possible sum-score¹ using a program developed by program written by Dr. Goodman in the R statistical language². It was essential to create these estimates in the same manner as the operational scoring tables created by NCDPI for each form using IRTPRO. To ensure that the methods used by Pacific Metrics in this step were congruent with NCDPI's process, Pacific Metrics re-created the operational scoring tables for each form and compared the results to NCDPI's RS-SS tables. Near perfect matches³ were achieved when employing the following steps:

¹ In this case, the sum-score reflects a test using all 180 operational items across all three forms within a mode. The entire pool was used to define as many points along the entire scale as possible. The sum-score was used to link the two sets of scale scores in the final concordance.

² This program was able to replicate the edition concordance between Editions 2 and 3 that used the score10.exe program developed by David Thissen. The R scripts are available upon request.

³ Across all six tables, differences of a single scale score point at three sum-scores on form C were observed. Further exploration of the unrounded scale scores show that in each case, the unrounded scores fall just above 0.5, thus rounding up to the next scale score. These minute differences in the unrounded scale scores were likely due to differential rounding rules for the two RS-SS production processes.

- Edition 3 parameters were rescaled to the normal metric by dividing each a parameter by 1.7
- EAP scores were produced using 33 quadrature points, ranging from -4.00 to 4.00 in intervals of 0.25.
- A standard normal prior was used in the estimation process.
- Scale scores were created by multiplying each EAP estimate by the Edition 3 scale score standard deviation (10) and adding the scale score mean (450). The resulting scores were rounded to the nearest integer.

The RS-SS tables produced in this step are found in the appendix (Table A1).

Screening for Anchor Item Stability

The set concordance linking items were screened for stability using a Delta plot (or Transformed Item Difficulty) method. This process assumes that the difficulty of the concordance linking items, if they are stable, will be *ordered* the same across the two editions despite being based on two different populations. Thus, instability was defined as significant differences in the relative difficulty of any item across editions. Item difficulties were transformed to the Delta scale and plotted. The plot's principal axis was defined, and items falling more than two standard errors away from this axis were flagged as unstable. For each mode of delivery, the entire set of linking items was screened in a single application of the Delta method.

For Biology, 5 items (43426, 43487, 43554, 43566, and 43570) were flagged as unstable in the online version of the test and three items (43426, 43487, and 43554) flagged as unstable on the paper version. In addition, one linking item (43456) was removed prior to the Delta analysis at NCDPI's request. The Delta plots for both modes are presented below. Results of the complete Delta analysis are found in the Appendix (Table A.2)

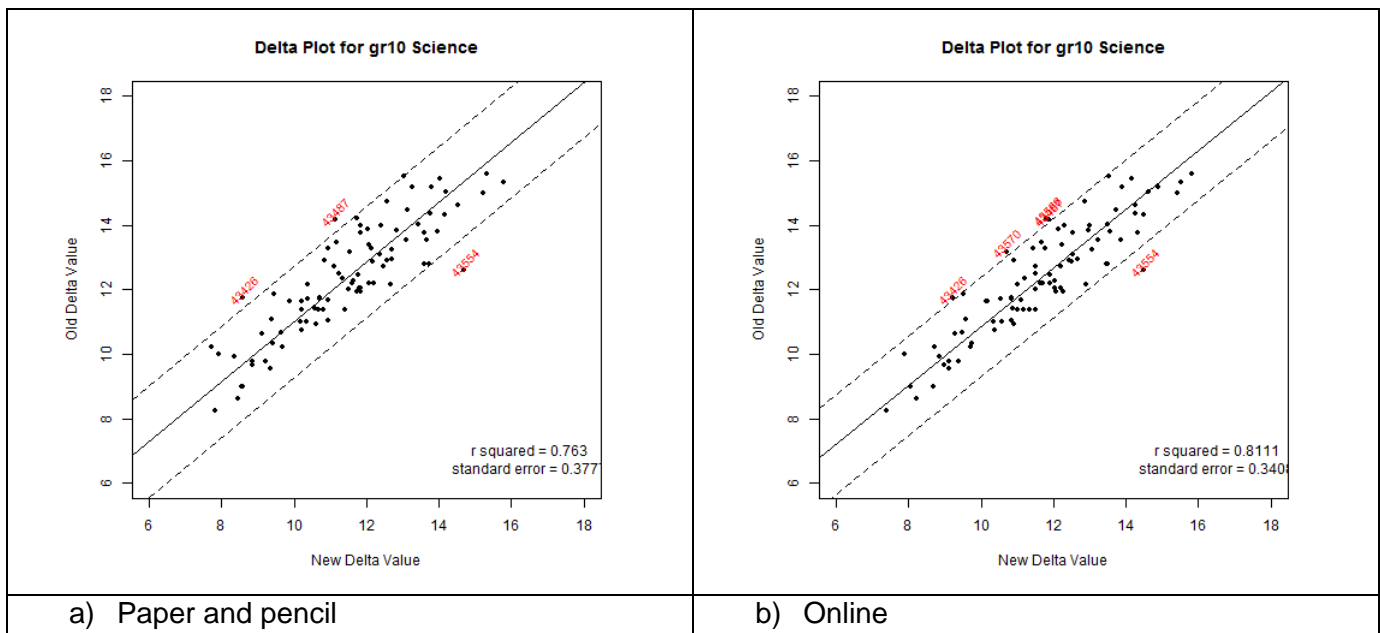


Figure 1: Delta Plots for Paper and Online Versions of the Biology Assessments

Rescaling the Edition 3 Parameters to the Edition 2 Bank Scale

Since the Edition 2 bank scale was established assuming a standard normal distribution ($D=1.7$) and the Edition 3 item parameters were calibrated with $D=1.0$ (a logistic distribution), the entire set of Edition 3 parameters (operational and concordance) were rescaled to be on the same metric as the Edition 2 parameters by dividing each a parameter by 1.7. Then, using the Edition 2 concordance item parameters and the normalized Edition 3 concordance item parameters, Stocking-Lord scaling constants were estimated two ways using a program developed by Dr. Goodman in the R statistical programming language⁴: 1) separately for each form; 2) using the entire set of linking items across all three forms. Given enough linking items, the form-by-form method of scaling was preferred as it dispenses with the assumption that each form was administered to an equivalent group. However, the scaling constants produced using the entire set of linking items was used as a QA step and provides an alternative scaling method should a large number of linking items be dropped from a single form or should a single form display a problematic scaling relationship.

Table 1 below displays the Stocking-Lord scaling constants for the two modes of administration by form and using the entire linking set. Figures 2 and 3 show the pre- and post-scaling TCC for each form and the overall linking set for the two modes. In all cases, post-scaling TCCs overlap almost completely. The normalized Edition 3 operational item parameters for each form were rescaled to the Edition 2 bank metric by applying the appropriate set of form-by-form Stocking-Lord scaling constants. The resulting item parameters were then reassembled into a single item pool for the next steps.

Table 1: Stocking-Lord Equating Constants

Form Pair	Paper		Online	
	A	B	A	B
A/M	0.9862	0.2511	0.9849	0.2137
B/N	0.9596	0.5775	0.9759	0.5661
C/O	1.0138	0.2303	1.0124	0.2111
All Items	0.9981	0.3531	1.0021	0.3234

⁴ The IRT scaling R script that includes the estimation of S-L constants is available upon request. In the development of this program, the estimated constants under four methods were compared to the constants estimated by STUIRT (Kim and Kolen, 2004) and PLINK (Weeks, 2010) for several sets of item parameters. Results were identical to those estimated within PLINK and nearly identical to those estimated by STUIRT.

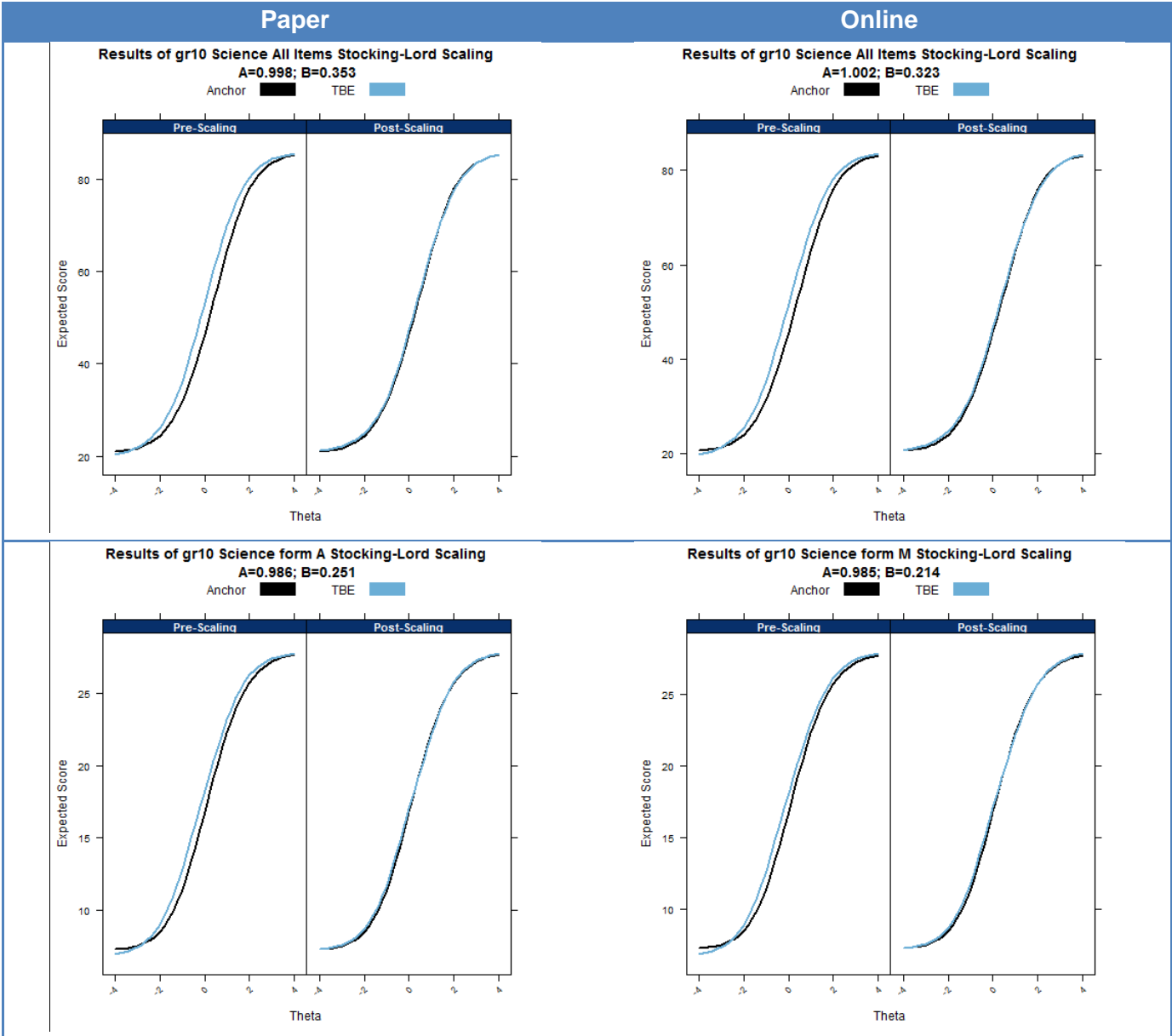


Figure 2: Pre- and Post-scaling TCC's for Entire Linking Set and Form Pair A/M

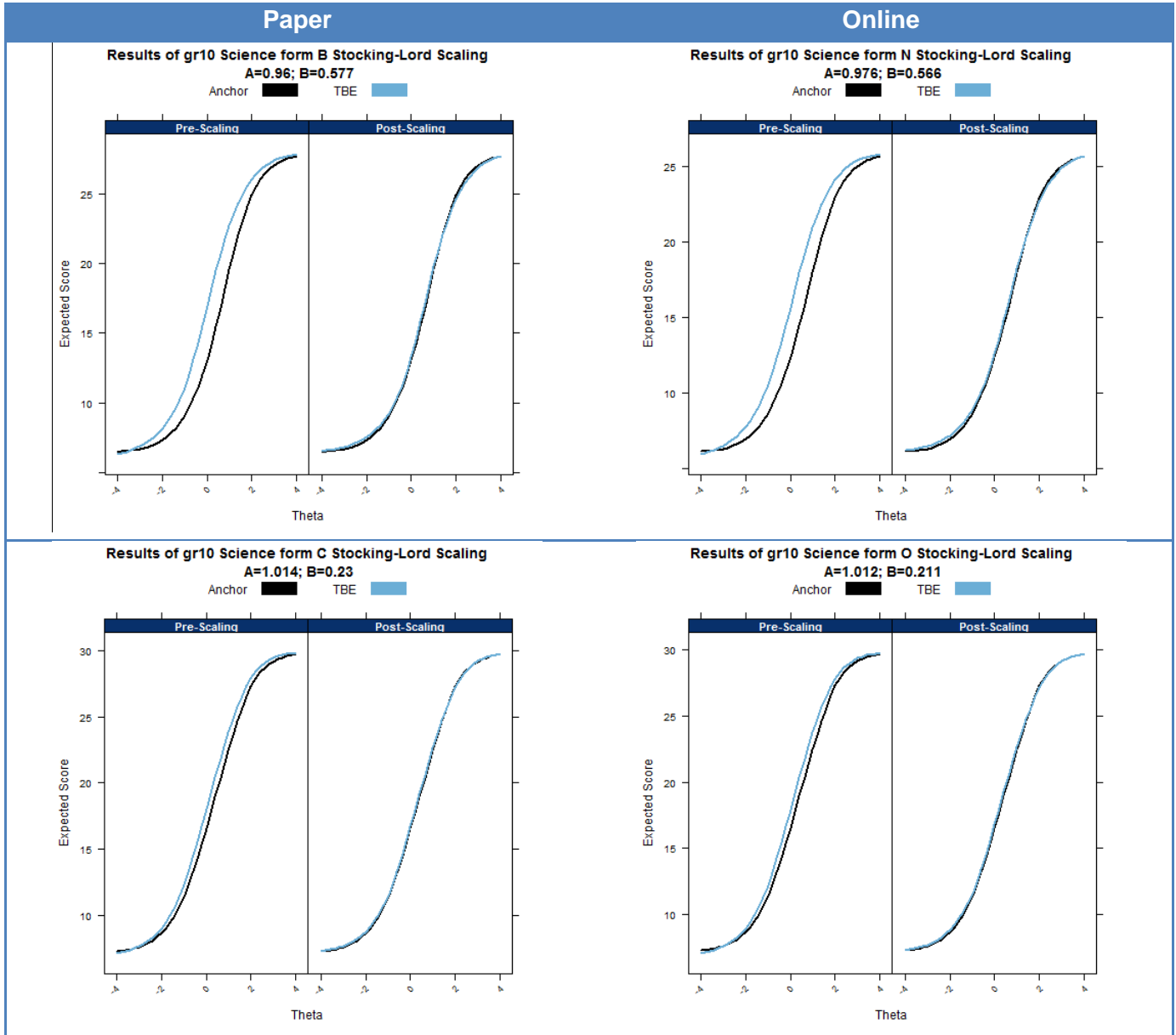


Figure 3: Pre- and Post-scaling TCC's for Form Pairs B/N and C/O

Creation of Edition 2 EAP estimates and Scale Scores Using Rescaled Parameters

Using the entire set of normalized and rescaled Edition 3 operational item parameters, an EAP score and corresponding Edition 2 scale scores were created for each possible sum-score⁵. The following steps are taken in the creation of these scores:

- EAP scores are produced using 33 quadrature points, ranging from -4.00 to 4.00 in intervals of 0.25.

⁵ This process was carried out using the same program as described in the creation of the edition 4 RS-SS tables.

- A standard normal prior is used in the estimation process.
- Scale scores are created by multiplying the EAP estimate by the Edition 2 scale score standard deviation (10) and adding the scale score mean (150). The resulting scores are rounded to the nearest integer.

The RS-SS tables produced in this step are found in the appendix (Table A3).

Creation of the Final Concordance tables

Merging, thinning, and interpolation

To create the initial concordance table, the Edition 3 tables and the Edition 2 tables based on all the operational items were merged by matching the sum-scores. The cut-scores (138,147, and 159) for Edition 2 were then applied to the Edition 2 scale scores in the table to show where the old proficiency classifications scores would fall on the Edition 3 scale.

The initial tables were thinned so that each Edition 3 scale score appears only once. If a scale score was replicated, table values associated with the lowest EAP values resulting in that Edition 3 scale score were retained. The final table must include values for the entire range of Edition 3 scale score values. For paper versions of the grade Biology concordance, there were no values for scores of 473, 476, 478, and 480 on the paper/pencil concordance and 474, 476, 478, and 480 on the online concordance. Linear Interpolation was used to generate Edition 2 EAP estimates (which were then converted to Edition 2 scale scores as described above) for these missing values on the Edition 3 scale. Figures 4 and 5 depict the final concordance between the editions for the two modes of administration. Also plotted in these figures are the concordances that were based on the results of each individual form. In both modes, the results for concordances based on all items and forms are similar.

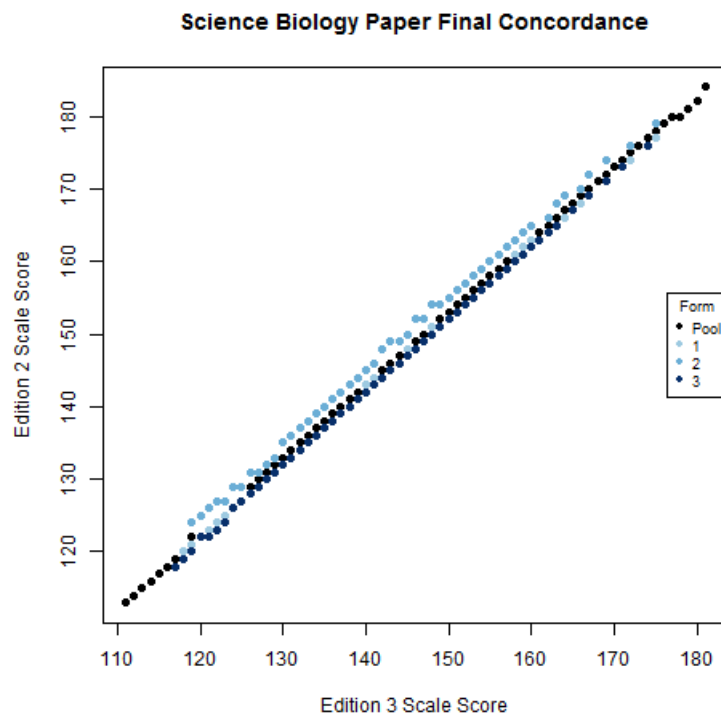


Figure 4: Final Concordance for Entire Pool and Forms A, B, & C

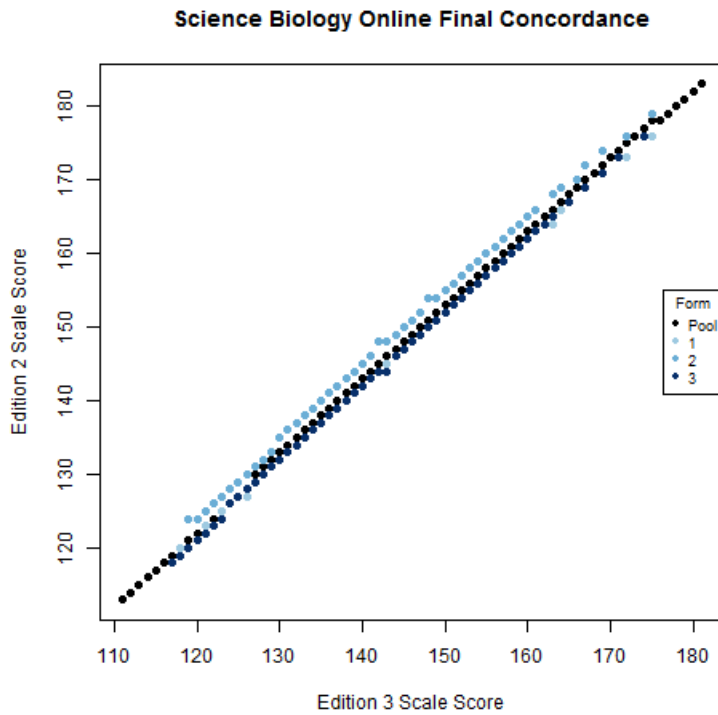


Figure 5: Final Concordance for Entire Pool and Forms M, N, & O

[Comparison of Concordance Tables across Mode](#)

The last step in creating the final concordances is to compare results across mode and decide on an approach for aggregation to create a single concordance relationship between editions. Figure 6 displays concordance for each mode. Overall, the relationship between Edition 3 and Edition 2 across mode is nearly identical with only a few minor differences at the two ends of score distribution. To create a single concordance relationship with the Edition 3 scale scores, the corresponding scale score for each model were averaged to create a single scale score equivalent for each Edition 3 scale point. The final Edition 3 to Edition 2 concordance table for Biology is presented in Table 2.

Paper and Online Concordance: Biology

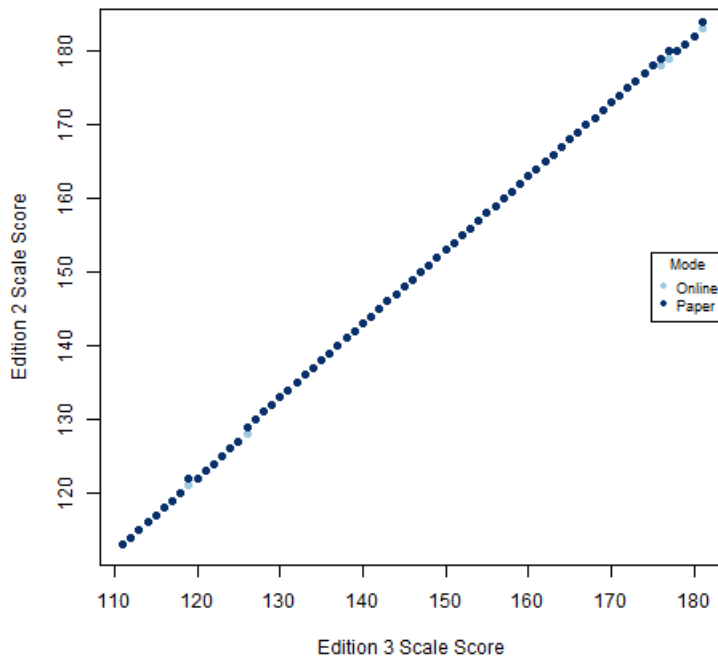


Figure 6: Comparison of Concordance Results across Mode of Administration

Table 2: Final Concordance Table for Biology

Ed. 3 Score	Online		Paper		Final (Aggregate)	
	Ed. 2 Score	Perf. Level	Ed. 2 Score	Perf. Level	Ed. 2 Score	Perf. Level
111	113	1	113	1	113	1
112	114	1	114	1	114	1
113	115	1	115	1	115	1
114	116	1	116	1	116	1
115	117	1	117	1	117	1
116	118	1	118	1	118	1
117	119	1	119	1	119	1
118	120	1	120	1	120	1
119	121	1	122	1	122	1
120	122	1	122	1	122	1
121	123	1	123	1	123	1
122	124	1	124	1	124	1
123	125	1	125	1	125	1
124	126	1	126	1	126	1
125	127	1	127	1	127	1

Ed. 3 Score	Online		Paper		Final (Aggregate)	
	Ed. 2 Score	Perf. Level	Ed. 2 Score	Perf. Level	Ed. 2 Score	Perf. Level
126	128	1	129	1	129	1
127	130	1	130	1	130	1
128	131	1	131	1	131	1
129	132	1	132	1	132	1
130	133	1	133	1	133	1
131	134	1	134	1	134	1
132	135	1	135	1	135	1
133	136	1	136	1	136	1
134	137	1	137	1	137	1
135	138	2	138	2	138	2
136	139	2	139	2	139	2
137	140	2	140	2	140	2
138	141	2	141	2	141	2
139	142	2	142	2	142	2
140	143	2	143	2	143	2
141	144	2	144	2	144	2
142	145	2	145	2	145	2
143	146	2	146	2	146	2
144	147	3	147	3	147	3
145	148	3	148	3	148	3
146	149	3	149	3	149	3
147	150	3	150	3	150	3
148	151	3	151	3	151	3
149	152	3	152	3	152	3
150	153	3	153	3	153	3
151	154	3	154	3	154	3
152	155	3	155	3	155	3
153	156	3	156	3	156	3
154	157	3	157	3	157	3
155	158	3	158	3	158	3
156	159	4	159	4	159	4
157	160	4	160	4	160	4
158	161	4	161	4	161	4
159	162	4	162	4	162	4
160	163	4	163	4	163	4
161	164	4	164	4	164	4
162	165	4	165	4	165	4

Ed. 3 Score	Online		Paper		Final (Aggregate)	
	Ed. 2 Score	Perf. Level	Ed. 2 Score	Perf. Level	Ed. 2 Score	Perf. Level
163	166	4	166	4	166	4
164	167	4	167	4	167	4
165	168	4	168	4	168	4
166	169	4	169	4	169	4
167	170	4	170	4	170	4
168	171	4	171	4	171	4
169	172	4	172	4	172	4
170	173	4	173	4	173	4
171	174	4	174	4	174	4
172	175	4	175	4	175	4
173	176	4	176	4	176	4
174	177	4	177	4	177	4
175	178	4	178	4	178	4
176	178	4	179	4	179	4
177	179	4	180	4	180	4
178	180	4	180	4	180	4
179	181	4	181	4	181	4
180	182	4	182	4	182	4
181	183	4	184	4	184	4

APPENDIX

Table A.1: Edition 3 RS-SS Table Based on All Operational Items

X	EAP X		SD(EAP X)		Scale Score		SD(Scale Score)	
	Paper	Online	Paper	Online	Paper	Online	Paper	Online
0	-3.93	-3.95	0.37	0.36	111	111	4	4
1	-3.91	-3.94	0.37	0.36	111	111	4	4
2	-3.90	-3.92	0.37	0.37	111	111	4	4
3	-3.88	-3.91	0.38	0.37	111	111	4	4
4	-3.87	-3.89	0.38	0.38	111	111	4	4
5	-3.85	-3.87	0.39	0.38	111	111	4	4
6	-3.83	-3.86	0.39	0.38	112	111	4	4
7	-3.82	-3.84	0.39	0.39	112	112	4	4
8	-3.80	-3.82	0.40	0.39	112	112	4	4
9	-3.78	-3.80	0.40	0.40	112	112	4	4
10	-3.76	-3.78	0.40	0.40	112	112	4	4
11	-3.74	-3.76	0.41	0.41	113	112	4	4
12	-3.72	-3.74	0.41	0.41	113	113	4	4
13	-3.70	-3.71	0.42	0.41	113	113	4	4
14	-3.68	-3.69	0.42	0.42	113	113	4	4
15	-3.65	-3.67	0.42	0.42	113	113	4	4
16	-3.63	-3.64	0.43	0.42	114	114	4	4
17	-3.61	-3.61	0.43	0.43	114	114	4	4
18	-3.58	-3.59	0.43	0.43	114	114	4	4
19	-3.55	-3.56	0.44	0.44	114	114	4	4
20	-3.53	-3.53	0.44	0.44	115	115	4	4
21	-3.50	-3.50	0.44	0.44	115	115	4	4
22	-3.47	-3.47	0.45	0.44	115	115	4	4
23	-3.44	-3.44	0.45	0.45	116	116	4	4
24	-3.41	-3.40	0.45	0.45	116	116	5	4
25	-3.37	-3.37	0.45	0.45	116	116	5	5
26	-3.34	-3.33	0.45	0.45	117	117	5	5
27	-3.31	-3.29	0.46	0.45	117	117	5	5
28	-3.27	-3.25	0.46	0.46	117	117	5	5
29	-3.23	-3.21	0.46	0.46	118	118	5	5
30	-3.19	-3.17	0.46	0.46	118	118	5	5
31	-3.15	-3.13	0.46	0.46	118	119	5	5
32	-3.11	-3.08	0.46	0.46	119	119	5	5
33	-3.07	-3.04	0.46	0.45	119	120	5	5
34	-3.03	-2.99	0.46	0.45	120	120	5	5

X	EAP X		SD(EAP X)		Scale Score		SD(Scale Score)	
	Paper	Online	Paper	Online	Paper	Online	Paper	Online
35	-2.98	-2.95	0.46	0.45	120	121	5	5
36	-2.94	-2.90	0.46	0.45	121	121	5	4
37	-2.89	-2.85	0.45	0.44	121	122	5	4
38	-2.85	-2.80	0.45	0.44	122	122	5	4
39	-2.80	-2.75	0.45	0.44	122	123	4	4
40	-2.75	-2.70	0.44	0.43	123	123	4	4
41	-2.70	-2.64	0.44	0.43	123	124	4	4
42	-2.65	-2.59	0.43	0.42	124	124	4	4
43	-2.60	-2.54	0.43	0.41	124	125	4	4
44	-2.54	-2.48	0.42	0.41	125	125	4	4
45	-2.49	-2.43	0.42	0.40	125	126	4	4
46	-2.44	-2.38	0.41	0.39	126	126	4	4
47	-2.39	-2.33	0.40	0.38	126	127	4	4
48	-2.34	-2.27	0.39	0.38	127	127	4	4
49	-2.28	-2.22	0.39	0.37	127	128	4	4
50	-2.23	-2.17	0.38	0.36	128	128	4	4
51	-2.18	-2.12	0.37	0.35	128	129	4	4
52	-2.13	-2.07	0.36	0.34	129	129	4	3
53	-2.08	-2.02	0.35	0.33	129	130	4	3
54	-2.03	-1.97	0.35	0.33	130	130	3	3
55	-1.98	-1.92	0.34	0.32	130	131	3	3
56	-1.93	-1.87	0.33	0.31	131	131	3	3
57	-1.88	-1.83	0.32	0.30	131	132	3	3
58	-1.84	-1.78	0.31	0.29	132	132	3	3
59	-1.79	-1.74	0.30	0.29	132	133	3	3
60	-1.74	-1.69	0.30	0.28	133	133	3	3
61	-1.70	-1.65	0.29	0.27	133	133	3	3
62	-1.66	-1.61	0.28	0.27	133	134	3	3
63	-1.61	-1.57	0.28	0.26	134	134	3	3
64	-1.57	-1.53	0.27	0.26	134	135	3	3
65	-1.53	-1.49	0.26	0.25	135	135	3	2
66	-1.49	-1.45	0.26	0.24	135	136	3	2
67	-1.45	-1.41	0.25	0.24	135	136	3	2
68	-1.41	-1.37	0.25	0.23	136	136	2	2
69	-1.38	-1.34	0.24	0.23	136	137	2	2
70	-1.34	-1.30	0.24	0.22	137	137	2	2
71	-1.30	-1.27	0.23	0.22	137	137	2	2
72	-1.27	-1.23	0.23	0.22	137	138	2	2

X	EAP X		SD(EAP X)		Scale Score		SD(Scale Score)	
	Paper	Online	Paper	Online	Paper	Online	Paper	Online
73	-1.23	-1.20	0.22	0.21	138	138	2	2
74	-1.20	-1.17	0.22	0.21	138	138	2	2
75	-1.16	-1.13	0.21	0.20	138	139	2	2
76	-1.13	-1.10	0.21	0.20	139	139	2	2
77	-1.10	-1.07	0.21	0.20	139	139	2	2
78	-1.06	-1.04	0.20	0.20	139	140	2	2
79	-1.03	-1.01	0.20	0.19	140	140	2	2
80	-1.00	-0.98	0.20	0.19	140	140	2	2
81	-0.97	-0.95	0.19	0.19	140	141	2	2
82	-0.94	-0.92	0.19	0.18	141	141	2	2
83	-0.91	-0.89	0.19	0.18	141	141	2	2
84	-0.88	-0.86	0.19	0.18	141	141	2	2
85	-0.85	-0.83	0.18	0.18	141	142	2	2
86	-0.82	-0.80	0.18	0.17	142	142	2	2
87	-0.79	-0.78	0.18	0.17	142	142	2	2
88	-0.77	-0.75	0.18	0.17	142	143	2	2
89	-0.74	-0.72	0.17	0.17	143	143	2	2
90	-0.71	-0.69	0.17	0.17	143	143	2	2
91	-0.68	-0.67	0.17	0.17	143	143	2	2
92	-0.66	-0.64	0.17	0.16	143	144	2	2
93	-0.63	-0.61	0.17	0.16	144	144	2	2
94	-0.60	-0.59	0.16	0.16	144	144	2	2
95	-0.58	-0.56	0.16	0.16	144	144	2	2
96	-0.55	-0.54	0.16	0.16	145	145	2	2
97	-0.52	-0.51	0.16	0.15	145	145	2	2
98	-0.50	-0.49	0.16	0.15	145	145	2	2
99	-0.47	-0.46	0.16	0.15	145	145	2	2
100	-0.45	-0.44	0.16	0.15	146	146	2	2
101	-0.42	-0.41	0.16	0.15	146	146	2	2
102	-0.40	-0.38	0.16	0.15	146	146	2	2
103	-0.37	-0.36	0.15	0.15	146	146	2	2
104	-0.34	-0.33	0.15	0.15	147	147	2	1
105	-0.32	-0.31	0.15	0.15	147	147	1	1
106	-0.30	-0.29	0.15	0.14	147	147	1	1
107	-0.27	-0.26	0.15	0.14	147	147	1	1
108	-0.25	-0.24	0.15	0.14	148	148	1	1
109	-0.22	-0.22	0.15	0.14	148	148	1	1
110	-0.20	-0.19	0.15	0.14	148	148	1	1

X	EAP X		SD(EAP X)		Scale Score		SD(Scale Score)	
	Paper	Online	Paper	Online	Paper	Online	Paper	Online
111	-0.17	-0.17	0.15	0.15	148	148	1	1
112	-0.15	-0.14	0.15	0.15	149	149	1	1
113	-0.12	-0.12	0.15	0.15	149	149	1	1
114	-0.10	-0.09	0.15	0.14	149	149	1	1
115	-0.07	-0.07	0.14	0.14	149	149	1	1
116	-0.05	-0.04	0.14	0.14	150	150	1	1
117	-0.03	-0.02	0.14	0.14	150	150	1	1
118	0.00	0.00	0.14	0.14	150	150	1	1
119	0.02	0.02	0.14	0.14	150	150	1	1
120	0.05	0.05	0.14	0.14	150	150	1	1
121	0.07	0.07	0.14	0.14	151	151	1	1
122	0.10	0.10	0.14	0.14	151	151	1	1
123	0.12	0.12	0.14	0.14	151	151	1	1
124	0.15	0.15	0.14	0.14	151	152	1	1
125	0.17	0.18	0.14	0.14	152	152	1	1
126	0.20	0.20	0.14	0.14	152	152	1	1
127	0.22	0.22	0.14	0.14	152	152	1	1
128	0.25	0.25	0.14	0.13	152	152	1	1
129	0.27	0.27	0.14	0.14	153	153	1	1
130	0.30	0.30	0.14	0.14	153	153	1	1
131	0.32	0.32	0.14	0.14	153	153	1	1
132	0.35	0.35	0.14	0.14	153	153	1	1
133	0.38	0.38	0.14	0.14	154	154	1	1
134	0.40	0.40	0.14	0.14	154	154	1	1
135	0.43	0.43	0.14	0.14	154	154	1	1
136	0.46	0.46	0.14	0.14	155	155	1	1
137	0.48	0.48	0.14	0.14	155	155	1	1
138	0.51	0.51	0.14	0.14	155	155	1	1
139	0.54	0.54	0.14	0.14	155	155	1	1
140	0.57	0.56	0.14	0.14	156	156	1	1
141	0.59	0.59	0.15	0.15	156	156	1	1
142	0.62	0.62	0.15	0.15	156	156	1	1
143	0.66	0.65	0.15	0.15	157	157	1	1
144	0.69	0.68	0.15	0.15	157	157	1	1
145	0.72	0.71	0.15	0.15	157	157	1	1
146	0.75	0.74	0.15	0.15	157	157	1	1
147	0.78	0.77	0.15	0.15	158	158	1	1
148	0.81	0.80	0.15	0.15	158	158	2	1

X	EAP X		SD(EAP X)		Scale Score		SD(Scale Score)	
	Paper	Online	Paper	Online	Paper	Online	Paper	Online
149	0.84	0.84	0.15	0.15	158	158	2	2
150	0.87	0.87	0.16	0.15	159	159	2	2
151	0.91	0.90	0.16	0.16	159	159	2	2
152	0.94	0.94	0.16	0.16	159	159	2	2
153	0.98	0.97	0.16	0.16	160	160	2	2
154	1.01	1.01	0.16	0.16	160	160	2	2
155	1.05	1.05	0.16	0.16	161	160	2	2
156	1.09	1.08	0.17	0.16	161	161	2	2
157	1.13	1.12	0.17	0.17	161	161	2	2
158	1.17	1.16	0.17	0.17	162	162	2	2
159	1.21	1.21	0.17	0.17	162	162	2	2
160	1.26	1.25	0.18	0.18	163	162	2	2
161	1.30	1.30	0.18	0.18	163	163	2	2
162	1.35	1.34	0.18	0.18	164	163	2	2
163	1.40	1.39	0.19	0.19	164	164	2	2
164	1.45	1.44	0.19	0.19	165	164	2	2
165	1.51	1.50	0.20	0.20	165	165	2	2
166	1.57	1.56	0.21	0.20	166	166	2	2
167	1.63	1.62	0.21	0.21	166	166	2	2
168	1.69	1.68	0.22	0.22	167	167	2	2
169	1.76	1.75	0.23	0.23	168	168	2	2
170	1.84	1.83	0.24	0.24	168	168	2	2
171	1.92	1.91	0.25	0.25	169	169	3	3
172	2.02	2.00	0.27	0.26	170	170	3	3
173	2.12	2.10	0.28	0.28	171	171	3	3
174	2.23	2.22	0.30	0.30	172	172	3	3
175	2.36	2.34	0.33	0.33	174	173	3	3
176	2.50	2.49	0.36	0.35	175	175	4	4
177	2.67	2.66	0.39	0.39	177	177	4	4
178	2.87	2.85	0.43	0.43	179	179	4	4
179	3.10	3.08	0.47	0.47	181	181	5	5

Table A.2: Delta Results

UIN	Form-Pair	P-value (ed. 3)	Delta (Ed. 3)	P-value (Ed. 4)		Delta (Ed. 4)		Standardized Residual	
				Paper	Online	Paper	Online	Paper	Online
43377	AM	0.84	8.99	0.87	0.89	8.55	8.07	-0.04	-1.09
43381	AM	0.53	12.72	0.55	0.58	12.47	12.21	-0.23	-1.00
43396	AM	0.63	11.68	0.70	0.68	10.94	11.09	-0.96	-0.96
43401	AM	0.59	12.06	0.62	0.59	11.81	12.05	-0.14	0.12
43404	AM	0.60	11.94	0.62	0.57	11.75	12.27	-0.01	0.82
43418	AM	0.52	12.80	0.44	0.45	13.58	13.48	1.61	1.34
43431	AM	0.42	13.77	0.44	0.37	13.59	14.31	-0.26	0.86
43433	AM	0.53	12.73	0.68	0.65	11.09	11.50	0.04	-0.21
43458	AM	0.80	9.67	0.85	0.84	8.85	8.99	-0.82	-0.76
43464	AM	0.72	10.67	0.80	0.81	9.66	9.50	-1.31	-0.73
43468	AM	0.61	11.85	0.81	0.81	9.45	9.51	1.29	1.81
43470	AM	0.77	9.99	0.90	0.90	7.91	7.90	0.43	0.95
43483	AM	0.40	14.02	0.46	0.45	13.42	13.50	-1.04	-1.27
43486	AM	0.66	11.37	0.72	0.69	10.67	10.99	-0.85	-0.47
43509	AM	0.71	10.76	0.76	0.75	10.20	10.36	-0.50	-0.39
43514	AM	0.45	13.53	0.49	0.48	13.10	13.24	-0.66	-0.72
43515	AM	0.29	15.17	0.42	0.32	13.80	14.89	-0.10	-1.01
43523	AM	0.57	12.34	0.66	0.67	11.35	11.21	-1.18	-0.48
43530	AM	0.58	12.21	0.59	0.63	12.06	11.70	0.01	-0.89
43545	AM	0.69	11.00	0.76	0.75	10.18	10.35	-1.01	-0.96
43554	AM	0.54	12.61	0.34	0.35	14.70	14.49	3.99	3.74
43558	AM	0.58	12.16	0.53	0.51	12.66	12.91	1.20	1.59
43567	AM	0.51	12.94	0.53	0.53	12.70	12.66	-0.26	-0.59
43585	AM	0.58	12.19	0.64	0.63	11.59	11.64	-0.78	-0.97
43591	AM	0.37	14.31	0.39	0.36	14.15	14.48	-0.29	0.04
43627	AM	0.69	11.06	0.70	0.70	10.94	10.85	0.25	-0.09
43630	AM	0.84	9.01	0.87	0.86	8.58	8.70	-0.02	0.12
43671	AM	0.62	11.76	0.72	0.70	10.70	10.85	-1.12	-1.04
43678	AM	0.79	9.76	0.83	0.82	9.21	9.38	-0.35	-0.16
43382	BN	0.51	12.92	0.54	0.56	12.56	12.44	-0.46	-0.98
43388	BN	0.55	12.51	0.67	0.64	11.25	11.52	-0.67	-0.74
43393	BN	0.33	14.73	0.54	0.51	12.58	12.86	1.24	1.43
43405	BN	0.76	10.24	0.91	0.86	7.71	8.72	1.29	-0.13
43421	BN	0.36	14.48	0.49	0.43	13.14	13.74	-0.25	-0.86
43425	BN	0.75	10.33	0.81	0.79	9.43	9.76	-1.06	-0.67
43426	BN	0.62	11.76	0.86	0.83	8.59	9.20	2.65	2.21

UIN	Form-Pair	P-value (ed. 3)	Delta (Ed. 3)	P-value (Ed. 4)		Delta (Ed. 4)		Standardized Residual	
				Paper	Online	Paper	Online	Paper	Online
43442	BN	0.26	15.52	0.50	0.45	13.02	13.54	2.00	1.80
43446	BN	0.45	13.48	0.68	0.63	11.17	11.66	1.36	1.10
43449	BN	0.51	12.88	0.58	0.55	12.15	12.52	-1.11	-0.74
43479	BN	0.72	10.63	0.83	0.82	9.11	9.27	-0.46	-0.36
43484	BN	0.63	11.71	0.72	0.70	10.71	10.86	-1.23	-1.15
43487	BN	0.39	14.17	0.68	0.61	11.13	11.87	2.77	2.18
43500	BN	0.47	13.29	0.70	0.65	10.95	11.42	1.39	1.15
43516	BN	0.78	9.91	0.88	0.85	8.37	8.87	-0.53	-1.13
43522	BN	0.40	13.98	0.62	0.57	11.83	12.30	1.16	0.91
43529	BN	0.49	13.08	0.56	0.55	12.38	12.52	-1.10	-1.16
43543	BN	0.31	15.02	0.38	0.34	14.20	14.63	-1.10	-1.21
43547	BN	0.43	13.75	0.61	0.55	11.85	12.52	0.66	-0.04
43557	BN	0.63	11.64	0.76	0.76	10.20	10.19	-0.46	0.01
43558	BN	0.58	12.16	0.74	0.69	10.37	11.01	0.24	-0.49
43566	BN	0.38	14.20	0.62	0.62	11.75	11.82	1.71	2.35
43570	BN	0.48	13.18	0.64	0.72	11.53	10.70	0.14	2.33
43572	BN	0.37	14.36	0.43	0.38	13.75	14.26	-1.10	-0.51
43588	BN	0.66	11.39	0.65	0.65	11.42	11.50	0.46	0.48
43593	BN	0.41	13.88	0.60	0.58	12.03	12.15	0.58	0.99
43605	BN	0.28	15.33	0.24	0.26	15.78	15.53	0.65	-0.11
43611	BN	0.48	13.25	0.53	0.49	12.69	13.06	-0.86	-0.47
43647	BN	0.63	11.64	0.78	0.76	9.87	10.13	0.12	0.12
43664	BN	0.47	13.28	0.59	0.62	12.12	11.76	-0.74	0.45
43397	CO	0.31	14.98	0.29	0.27	15.21	15.42	0.32	0.44
43401	CO	0.59	12.06	0.61	0.58	11.84	12.19	-0.09	0.38
43404	CO	0.60	11.94	0.61	0.59	11.85	12.08	0.17	0.44
43409	CO	0.60	12.02	0.65	0.64	11.50	11.52	-0.62	-0.85
43418	CO	0.52	12.80	0.43	0.46	13.72	13.45	1.85	1.27
43429	CO	0.26	15.58	0.28	0.24	15.31	15.82	-0.67	-0.08
43435	CO	0.57	12.25	0.63	0.60	11.63	12.04	-0.84	-0.33
43445	CO	0.63	11.72	0.74	0.73	10.37	10.56	-0.62	-0.55
43457	CO	0.55	12.46	0.62	0.61	11.78	11.92	-0.97	-1.02
43460	CO	0.51	12.92	0.71	0.70	10.83	10.91	0.88	1.36
43472	CO	0.66	11.40	0.73	0.70	10.58	10.87	-1.08	-0.79
43486	CO	0.66	11.37	0.71	0.66	10.82	11.33	-0.57	0.20
43496	CO	0.66	11.39	0.76	0.67	10.22	11.19	-0.99	-0.14
43498	CO	0.34	14.62	0.35	0.38	14.54	14.26	-0.20	-1.06

UIN	Form-Pair	P-value (ed. 3)	Delta (Ed. 3)	P-value (Ed. 4)		Delta (Ed. 4)		Standardized Residual	
				Paper	Online	Paper	Online	Paper	Online
43501	CO	0.42	13.82	0.52	0.50	12.82	12.97	-0.94	-0.76
43514	CO	0.45	13.53	0.44	0.42	13.65	13.86	0.32	0.50
43515	CO	0.29	15.17	0.48	0.41	13.25	13.88	0.89	0.36
43522	CO	0.40	13.98	0.56	0.50	12.40	13.00	0.12	-0.46
43526	CO	0.27	15.45	0.40	0.39	14.04	14.15	0.03	0.45
43530	CO	0.58	12.21	0.58	0.61	12.19	11.90	0.26	-0.51
43545	CO	0.69	11.00	0.75	0.73	10.34	10.59	-0.73	-0.48
43569	CO	0.46	13.40	0.59	0.57	12.07	12.25	-0.41	-0.25
43579	CO	0.81	9.55	0.82	0.83	9.35	9.13	0.30	-0.22
43631	CO	0.86	8.63	0.87	0.88	8.46	8.23	0.49	0.00
43653	CO	0.76	10.22	0.80	0.79	9.70	9.72	-0.37	-0.50
43655	CO	0.70	10.92	0.72	0.70	10.62	10.90	-0.07	0.33
43661	CO	0.88	8.25	0.90	0.92	7.83	7.41	0.11	-0.78
43663	CO	0.68	11.08	0.82	0.80	9.40	9.59	-0.10	-0.01
43678	CO	0.79	9.76	0.85	0.84	8.85	9.10	-1.00	-0.72
43683	CO	0.42	13.78	0.41	0.44	13.95	13.58	0.37	-0.61

Table A.3: Edition 2 RS-SS Table Based on All Operational Items

X	EAP X		SD(EAP X)		Scale Score		SD(Scale Score)	
	Paper	Online	Paper	Online	Paper	Online	Paper	Online
0	-3.70	-3.75	0.42	0.41	113	113	4	4
1	-3.69	-3.73	0.42	0.41	113	113	4	4
2	-3.67	-3.71	0.42	0.42	113	113	4	4
3	-3.65	-3.70	0.43	0.42	113	113	4	4
4	-3.64	-3.68	0.43	0.42	114	113	4	4
5	-3.62	-3.66	0.43	0.43	114	113	4	4
6	-3.60	-3.64	0.44	0.43	114	114	4	4
7	-3.58	-3.62	0.44	0.43	114	114	4	4
8	-3.56	-3.60	0.44	0.44	114	114	4	4
9	-3.54	-3.58	0.44	0.44	115	114	4	4
10	-3.52	-3.56	0.45	0.44	115	114	4	4
11	-3.50	-3.54	0.45	0.44	115	115	5	4
12	-3.48	-3.51	0.45	0.45	115	115	5	4
13	-3.45	-3.49	0.46	0.45	115	115	5	5
14	-3.43	-3.46	0.46	0.45	116	115	5	5
15	-3.41	-3.44	0.46	0.46	116	116	5	5
16	-3.38	-3.41	0.46	0.46	116	116	5	5
17	-3.36	-3.38	0.47	0.46	116	116	5	5
18	-3.33	-3.35	0.47	0.46	117	116	5	5
19	-3.30	-3.32	0.47	0.47	117	117	5	5
20	-3.27	-3.29	0.47	0.47	117	117	5	5
21	-3.24	-3.26	0.47	0.47	118	117	5	5
22	-3.21	-3.23	0.48	0.47	118	118	5	5
23	-3.18	-3.19	0.48	0.47	118	118	5	5
24	-3.15	-3.16	0.48	0.48	119	118	5	5
25	-3.11	-3.12	0.48	0.48	119	119	5	5
26	-3.08	-3.09	0.48	0.48	119	119	5	5
27	-3.04	-3.05	0.48	0.48	120	120	5	5
28	-3.01	-3.01	0.48	0.48	120	120	5	5
29	-2.97	-2.96	0.48	0.48	120	120	5	5
30	-2.93	-2.92	0.48	0.48	121	121	5	5
31	-2.89	-2.88	0.48	0.48	121	121	5	5
32	-2.85	-2.83	0.48	0.48	122	122	5	5
33	-2.80	-2.79	0.48	0.48	122	122	5	5
34	-2.76	-2.74	0.48	0.47	122	123	5	5
35	-2.71	-2.69	0.48	0.47	123	123	5	5
36	-2.67	-2.64	0.48	0.47	123	124	5	5

X	EAP X		SD(EAP X)		Scale Score		SD(Scale Score)	
	Paper	Online	Paper	Online	Paper	Online	Paper	Online
37	-2.62	-2.59	0.48	0.46	124	124	5	5
38	-2.57	-2.54	0.47	0.46	124	125	5	5
39	-2.52	-2.49	0.47	0.46	125	125	5	5
40	-2.47	-2.43	0.46	0.45	125	126	5	5
41	-2.42	-2.38	0.46	0.44	126	126	5	4
42	-2.36	-2.32	0.45	0.44	126	127	5	4
43	-2.31	-2.27	0.45	0.43	127	127	4	4
44	-2.26	-2.21	0.44	0.42	127	128	4	4
45	-2.20	-2.16	0.44	0.42	128	128	4	4
46	-2.15	-2.10	0.43	0.41	129	129	4	4
47	-2.09	-2.05	0.42	0.40	129	130	4	4
48	-2.04	-1.99	0.41	0.39	130	130	4	4
49	-1.98	-1.94	0.40	0.38	130	131	4	4
50	-1.93	-1.88	0.40	0.37	131	131	4	4
51	-1.88	-1.83	0.39	0.36	131	132	4	4
52	-1.82	-1.78	0.38	0.36	132	132	4	4
53	-1.77	-1.73	0.37	0.35	132	133	4	3
54	-1.72	-1.68	0.36	0.34	133	133	4	3
55	-1.66	-1.63	0.35	0.33	133	134	4	3
56	-1.61	-1.58	0.34	0.32	134	134	3	3
57	-1.56	-1.53	0.33	0.31	134	135	3	3
58	-1.51	-1.48	0.32	0.30	135	135	3	3
59	-1.47	-1.44	0.32	0.30	135	136	3	3
60	-1.42	-1.39	0.31	0.29	136	136	3	3
61	-1.37	-1.35	0.30	0.28	136	137	3	3
62	-1.33	-1.30	0.29	0.27	137	137	3	3
63	-1.28	-1.26	0.28	0.27	137	137	3	3
64	-1.24	-1.22	0.28	0.26	138	138	3	3
65	-1.20	-1.18	0.27	0.26	138	138	3	3
66	-1.16	-1.14	0.26	0.25	138	139	3	2
67	-1.12	-1.10	0.26	0.24	139	139	3	2
68	-1.08	-1.06	0.25	0.24	139	139	3	2
69	-1.04	-1.02	0.25	0.23	140	140	2	2
70	-1.00	-0.99	0.24	0.23	140	140	2	2
71	-0.96	-0.95	0.24	0.22	140	140	2	2
72	-0.93	-0.92	0.23	0.22	141	141	2	2
73	-0.89	-0.88	0.23	0.22	141	141	2	2
74	-0.85	-0.85	0.22	0.21	141	142	2	2

X	EAP X		SD(EAP X)		Scale Score		SD(Scale Score)	
	Paper	Online	Paper	Online	Paper	Online	Paper	Online
75	-0.82	-0.82	0.22	0.21	142	142	2	2
76	-0.79	-0.78	0.21	0.20	142	142	2	2
77	-0.75	-0.75	0.21	0.20	142	143	2	2
78	-0.72	-0.72	0.21	0.20	143	143	2	2
79	-0.69	-0.69	0.20	0.19	143	143	2	2
80	-0.65	-0.66	0.20	0.19	143	143	2	2
81	-0.62	-0.63	0.20	0.19	144	144	2	2
82	-0.59	-0.60	0.19	0.19	144	144	2	2
83	-0.56	-0.57	0.19	0.18	144	144	2	2
84	-0.53	-0.54	0.19	0.18	145	145	2	2
85	-0.50	-0.51	0.18	0.18	145	145	2	2
86	-0.47	-0.48	0.18	0.18	145	145	2	2
87	-0.44	-0.45	0.18	0.17	146	145	2	2
88	-0.42	-0.42	0.18	0.17	146	146	2	2
89	-0.39	-0.40	0.18	0.17	146	146	2	2
90	-0.36	-0.37	0.17	0.17	146	146	2	2
91	-0.33	-0.34	0.17	0.17	147	147	2	2
92	-0.30	-0.32	0.17	0.16	147	147	2	2
93	-0.28	-0.29	0.17	0.16	147	147	2	2
94	-0.25	-0.26	0.17	0.16	147	147	2	2
95	-0.22	-0.24	0.16	0.16	148	148	2	2
96	-0.20	-0.21	0.16	0.16	148	148	2	2
97	-0.17	-0.19	0.16	0.16	148	148	2	2
98	-0.14	-0.16	0.16	0.16	149	148	2	2
99	-0.12	-0.13	0.16	0.16	149	149	2	2
100	-0.09	-0.11	0.16	0.15	149	149	2	2
101	-0.07	-0.08	0.15	0.15	149	149	2	2
102	-0.04	-0.06	0.15	0.15	150	149	2	1
103	-0.02	-0.03	0.15	0.15	150	150	2	1
104	0.01	-0.01	0.15	0.15	150	150	1	1
105	0.03	0.01	0.15	0.15	150	150	1	1
106	0.06	0.04	0.15	0.15	151	150	2	1
107	0.08	0.06	0.15	0.15	151	151	2	1
108	0.11	0.09	0.15	0.15	151	151	2	1
109	0.13	0.11	0.15	0.15	151	151	1	1
110	0.16	0.14	0.15	0.15	152	151	1	1
111	0.18	0.16	0.14	0.14	152	152	1	1
112	0.20	0.19	0.14	0.14	152	152	1	1

X	EAP X		SD(EAP X)		Scale Score		SD(Scale Score)	
	Paper	Online	Paper	Online	Paper	Online	Paper	Online
113	0.23	0.21	0.14	0.14	152	152	1	1
114	0.25	0.23	0.14	0.14	153	152	1	1
115	0.27	0.25	0.14	0.14	153	153	1	1
116	0.30	0.28	0.14	0.14	153	153	1	1
117	0.32	0.30	0.14	0.14	153	153	1	1
118	0.35	0.33	0.14	0.14	153	153	1	1
119	0.37	0.35	0.14	0.14	154	154	1	1
120	0.40	0.38	0.14	0.14	154	154	1	1
121	0.42	0.40	0.14	0.14	154	154	1	1
122	0.45	0.43	0.14	0.14	154	154	1	1
123	0.47	0.45	0.14	0.14	155	155	1	1
124	0.50	0.47	0.13	0.13	155	155	1	1
125	0.52	0.50	0.14	0.13	155	155	1	1
126	0.54	0.52	0.14	0.13	155	155	1	1
127	0.57	0.54	0.14	0.14	156	155	1	1
128	0.59	0.57	0.14	0.14	156	156	1	1
129	0.62	0.60	0.14	0.14	156	156	1	1
130	0.65	0.62	0.14	0.14	156	156	1	1
131	0.67	0.65	0.14	0.14	157	156	1	1
132	0.70	0.68	0.14	0.14	157	157	1	1
133	0.72	0.70	0.14	0.14	157	157	1	1
134	0.75	0.73	0.14	0.14	157	157	1	1
135	0.77	0.75	0.14	0.14	158	158	1	1
136	0.80	0.78	0.14	0.14	158	158	1	1
137	0.83	0.80	0.14	0.14	158	158	1	1
138	0.86	0.83	0.14	0.14	159	158	1	1
139	0.88	0.86	0.15	0.15	159	159	1	1
140	0.91	0.89	0.15	0.15	159	159	1	1
141	0.94	0.92	0.14	0.15	159	159	1	1
142	0.97	0.95	0.14	0.14	160	159	1	1
143	1.00	0.98	0.14	0.14	160	160	1	1
144	1.03	1.00	0.14	0.14	160	160	1	1
145	1.06	1.03	0.15	0.15	161	160	1	1
146	1.09	1.06	0.15	0.15	161	161	1	1
147	1.12	1.09	0.15	0.15	161	161	2	2
148	1.15	1.13	0.15	0.15	162	161	2	2
149	1.18	1.16	0.15	0.15	162	162	2	2
150	1.22	1.19	0.15	0.15	162	162	2	2

X	EAP X		SD(EAP X)		Scale Score		SD(Scale Score)	
	Paper	Online	Paper	Online	Paper	Online	Paper	Online
151	1.25	1.23	0.15	0.15	162	162	2	2
152	1.28	1.26	0.16	0.16	163	163	2	2
153	1.32	1.30	0.16	0.16	163	163	2	2
154	1.35	1.33	0.16	0.16	164	163	2	2
155	1.39	1.37	0.16	0.16	164	164	2	2
156	1.43	1.41	0.17	0.17	164	164	2	2
157	1.47	1.45	0.17	0.17	165	164	2	2
158	1.51	1.49	0.17	0.17	165	165	2	2
159	1.55	1.53	0.17	0.17	166	165	2	2
160	1.60	1.57	0.18	0.18	166	166	2	2
161	1.64	1.62	0.18	0.18	166	166	2	2
162	1.69	1.67	0.18	0.18	167	167	2	2
163	1.74	1.72	0.19	0.19	167	167	2	2
164	1.79	1.77	0.19	0.19	168	168	2	2
165	1.84	1.82	0.20	0.20	168	168	2	2
166	1.90	1.88	0.20	0.20	169	169	2	2
167	1.96	1.94	0.21	0.21	170	169	2	2
168	2.03	2.00	0.22	0.22	170	170	2	2
169	2.09	2.07	0.22	0.22	171	171	2	2
170	2.17	2.15	0.23	0.23	172	171	2	2
171	2.25	2.23	0.25	0.25	172	172	2	2
172	2.34	2.32	0.26	0.26	173	173	3	3
173	2.43	2.41	0.27	0.27	174	174	3	3
174	2.54	2.52	0.29	0.29	175	175	3	3
175	2.67	2.64	0.31	0.31	177	176	3	3
176	2.80	2.78	0.34	0.34	178	178	3	3
177	2.96	2.94	0.37	0.37	180	179	4	4
178	3.15	3.13	0.41	0.41	181	181	4	4
179	3.36	3.34	0.44	0.44	184	183	4	4