Simulation Study for Evaluating MAP® Growth™ Item Pools with Grade-Level Constraints

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Sylvia Li and Patrick Meyer, NWEA Psychometric Solutions

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1. Introduction

This simulation study examines the measurement precision, item exposure rates, and the depth of the MAP® Growth™ item pools under various grade-level restrictions. Unlike most summative assessments, MAP Growth allows examinees to see items from any grade level, regardless of the examinee's actual grade level. It does not limit the test to items designated for the examinee's actual grade. A benefit of this flexibility is that the test may adapt to the examinee's ability level regardless of grade, which can avoid examinee frustration and emotional trauma (Thurlow, Elliott, & Ysseldyke, 1999). It can also substantially improve the measurement of students who are performing significantly below or above the grade level. In addition, this approach is consistent with measuring growth rather than just status for accountability purposes. As long as test scores and the vertically articulated standards are expressed on the same scale, each student can be compared to the same "on-grade" standards regardless whether or not they received off-grade items in their individual test (Way et al., 2010). The downside is that the examinee may see items that are not aligned to the curriculum for a particular grade. A developmental scale that is not restricted to grade-level content enables a teacher to identify where students are in their learning, and to modify instruction accordingly. Low performing students may need remedial content before grade-level content. A high performing student may need to be challenged with above-grade content during instruction.

On the other hand, teachers are accountable for teaching grade-level content. Grade level serves as the organizing basis for curriculum and instruction, therefore a test focused on grade-level content arguably provides a better measure of on-grade learning. If a test is used to drive changes in instructional practices, on-grade assessment is more appropriate than out-of-level assessment (Thurlow, Elliott, & Ysseldyke, 1999). However, researchers found that student performance on grade-level assessment is likely to be higher than their performance on out-of-level assessments due to overestimation provided by high proportions of chance level scores (Doscher & Bruno, 1981; Wick, 1983).
The purposes of this research study are as follows:

1. To explore different possible test designs using on-grade items only with the current MAP Growth item pools
2. To provide recommendations to Content Solutions for developing grade-level items

Specifically, this study evaluates the depth of MAP Growth on-grade item pools along the student ability spectrum based on empirical Rasch Unit (RIT) score distributions. The study manipulated two factors: the type of item pool and type of simulee. Different item pools were created for the simulations with the following restrictions to explore the feasibility of creating on-grade MAP Growth assessments. Simulee groups were based on on-grade and off-grade student ability.

- On-grade item pools that were limited to on-grade items only. For example, the Grade 4 item pool was created for simulees assigned to Grade 4.
- ±1 grade item pools that contained items for the target grade plus items one grade below and one grade above the target grade. For example, a Grade 4 simulee would encounter items appropriate for Grades 3, 4, and 5.
- All-grade item pools that are used in the current MAP Growth 2–5, 6+, and 2–12 tests and have no grade-level restrictions. A simulee could see items from all possible grade levels.

1.1. Background

Four major components of a computerized adaptive test (CAT) are the item pool, item selection method, ability estimation method, and stopping rule (Reckase, 1989). Of these components, item pool quality is the foundation for a CAT to achieve desirable psychometric properties (Veldkamp & van der Linden, 2000; Xing & Hambleton, 2004; van der Linden, Ariel, & Veldkamp, 2006; Reckase, 2010). A high-quality item pool should contain an adequate number of items that support efficient and informative testing across important ability levels (Wise, 1997). The item pool must also "contain high-quality items for many different levels of proficiency" for a test that claims to measure students at different ability levels (Flaugher, 2000, p. 38). If the item pool is shallow in some ability levels, the CAT will be less efficient in terms of ability estimation (Wise, 1997).

Wise (1997) evaluated CAT item pools regarding pool size, adequacy of the test information provided by the pool, and balance of content domains and item difficulties. He provided recommendations regarding targeted expansion of the item pools and adopting more efficient testing methods (e.g., the AMT[1] procedure). More relevant to the current study, Wei and Lin (2015) investigated the use of out-of-level items versus grade-level items in CAT through simulations. In their study, items from adjacent grades were treated as out-of-level items and were pooled together with in-level items. Their findings indicated that administering out-of-level items improved measurement accuracy and test efficiency for low- and high-performing students but did not impact students in the middle of the ability spectrum.

[1] Adaptive mastery testing (Weiss & Kingsbury, 1984).

1.2. Data

The following item pools and data were used in this simulation study:

- MAP Growth Mathematics, Reading, and Language Usage item pools for Grades 3–8 aligned to the Common Core State Standards (CCSS; National Governors Association Center for Best Practices & Council of Chief State School Officers [CCSSO], 2010)[2] based on the three item pool restrictions (i.e., on-grade, ±1 grade, and all-grade)
- Study sample: test event data extracted from the Growth Research Database (GRD) for the 2016–2017 school year

As shown in Table 1.1, the simulations included 21 on-grade item pools, 21 ±1 grade item pools, and five all-grade item pools. On-grade and all-grade item pools were obtained directly from item pool data. For the ±1 grade item pools, items from three grades were combined and the number of items was obtained by counting unique item IDs across the three grade levels. Test event data was obtained from CCSS MAP Growth tests administered in 2016–2017. Table 1.2 summarizes student RIT distributions from those test events.

Table 1.1. Simulation Study Item Pools

		On-Grade		±1 Grade		All-Grade	
Content Area	Grade	Item Pool	#Items	Item Pool	#Items	Item Pool	#Items
Mathematics	2	Math 2	689	Math 1–3	1,926	Math 2–5	4,793
	3	Math 3	928	Math 2–4	2,543		
	4	Math 4	1,020	Math 3–5	2,598		
	5	Math 5	822	Math 4–6	2,815		
	6	Math 6	1,166	Math 5–7	2,742	Math 6–8	6,657
	7	Math 7	945	Math 6–8	2,716		
	8	Math 8	718	Math 7–9	2,824		
Reading	2	Read 2	584	Read 1–3	1,324	Read 2–5	5,727
	3	Read 3	1,072	Read 2–4	2,012		
	4	Read 4	1,216	Read 3–5	2,271		
	5	Read 5	969	Read 4–6	2,441		
	6	Read 6	1,036	Read 5–7	2,106	Read 6–8	6,472
	7	Read 7	697	Read 6–8	1,893		
	8	Read 8	710	Read 7–9	1,382		
Language Usage	2	Lang 2	445	Lang 1–3	1,621	Lang 2–12	5,536
	3	Lang 3	922	Lang 2–4	1,771		
	4	Lang 4	1,004	Lang 3–5	1,910		
	5	Lang 5	681	Lang 4–6	1,730		
	6	Lang 6	512	Lang 5–7	1,284		
	7	Lang 7	509	Lang 6–8	1,005		
	8	Lang 8	366	Lang 7–9	861		

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Table 1.2. Student RIT Distributions from 2016–2017 CCSS Test Event Data

Content Area	Grade	#Students	RIT Descriptive Statistics				
			Mean	SD	Median	Skewness	Kurtosis
Mathematics	2	1,386,531	183.00	15.97	183.50	-0.21	0.41
	3	1,464,118	194.00	14.86	194.61	-0.33	0.72
	4	1,454,385	205.00	15.56	205.34	-0.31	0.96
	5	1,457,360	214.00	16.95	214.03	-0.26	0.75
	6	1,414,750	217.00	16.99	218.14	-0.35	0.73
	7	1,356,673	223.00	18.39	224.28	-0.33	0.55
	8	1,301,542	229.00	19.33	229.42	-0.32	0.53
Reading	2	1,351,809	180.33	17.80	181.33	-0.12	-0.59
	3	1,445,055	191.65	17.44	193.68	-0.41	-0.24
	4	1,440,187	200.66	16.91	202.82	-0.63	0.39
	5	1,440,237	207.52	16.59	209.43	-0.73	0.82
	6	1,374,256	212.27	16.34	214.28	-0.83	1.21
	7	1,329,350	216.39	16.41	218.38	-0.87	1.40
	8	1,288,344	220.21	16.33	222.15	-0.91	1.64
Language Usage	2	239,959	180.49	16.93	180.88	0.08	-0.89
	3	378,455	192.00	16.14	194.04	-0.38	-0.42
	4	411,293	200.52	15.41	202.62	-0.64	0.27
	5	410,999	206.65	14.91	208.60	-0.79	0.85
	6	426,644	211.13	14.85	213.02	-0.84	1.17
	7	405,557	214.89	14.79	216.68	-0.86	1.41
	8	393,550	218.37	14.78	220.02	-0.85	1.60

2. Method

CAT simulations were performed using the SAS sandbox tool (Wang, 2016). To ensure that the simulations accurately reflected the operational MAP Growth tests, the test length, item selection by content balancing, and standard error of measurement (SEM) criteria for the simulations were the same as those used in the operational MAP Growth tests. Owen's Bayesian method (Owen, 1975) was used for momentary person ability calculations, and the maximum likelihood estimation (MLE) method was used final ability estimation. All item difficulty values and person ability scores were on the RIT scale, which has a mean of 200 and a standard deviation (SD) of 10 for each content area. Table 2.1 presents the test specifications followed in the simulations. While the number of administrations per year and longitudinal constraint are used in operational test validation, they are not considered at this point in this simulation study.

Table 2.1. Test Specifications

Test	Grades	Length	Instructional Area
MAP Growth Mathematics 2–5	2–5	50	Geometry Measurement and Data Number and Operations Operations and Algebraic Thinking
MAP Growth Mathematics 6+	6–8	50	Geometry Operations and Algebraic Thinking Statistics and Probability The Real and Complex Number Systems
MAP Growth Reading 2–5	2–5	40	Informational Text: Key Ideas and Details Informational Text: Language, Craft, and Structure Literary Text: Key Ideas and Details Literary Text: Language, Craft, and Structure Vocabulary: Acquisition and Use
MAP Growth Reading 6+	6–8	40	Informational Text: Key Ideas and Details Informational Text: Language, Craft, and Structure Literary Text: Key Ideas and Details Literary Text: Language, Craft, and Structure Vocabulary: Acquisition and Use
MAP Growth Language 2–12	2–8	50	Language: Understand, Edit for Grammar, Usage Language: Understand, Edit for Mechanics Writing: Write, Revise Texts for Purpose and Audience

Note. Length is the number of items on the assessment.

2.1. Simulation Conditions

The simulation study design implemented the following two factors that were crossed to yield six conditions (e.g., on-grade item pool with on-grade student ability; on-grade item pool with off-grade student ability; ±1 grade item pool with on-grade student ability; etc.). In each condition, 500 simulees were assigned to each true RIT point.

1. Item pool (on-grade, ±1 grade, and all-grade)
2. Student ability level (students with on-grade ability and students with off-grade ability)

2.1.1. On-Grade Student Ability

Student's true RITs were drawn from empirical distributions summarized from the 2016–2017 CCSS MAP Growth test scores in Table 1.2. Seven RIT points (R1 – R7) were obtained for each grade and content area based on the mean and SD of the student RIT distribution. Table 2.2 presents the true RIT points for each grade and content area. R4, the middle point, was the mean. RIT points ranged from two SDs below the mean to two SDs above the mean (i.e., -2SD to 2SD). Specifically, the RIT points below the mean were -2SD (R1), -1.5SD (R2), and -1SD (R3), and the RIT points above the mean were 1SD (R5), 1.5SD (R6), and 2SD (R7). For simulation conditions with on-grade simulees, a total of 3,500 test events (500 × 7 = 3,500) were simulated for each grade and content area.

Table 2.2. True RITs for On-Grade Student Ability

		True RIT						
Content Area	**Grade**	**R1**	**R2**	**R3**	**R4 (Mean)**	**R5**	**R6**	**R7**
Mathematics	2	151	159	167	183	199	207	215
	3	164	172	179	194	209	216	224
	4	174	181	189	205	220	228	236
	5	180	188	197	214	230	239	247
	6	183	192	200	217	234	243	251
	7	187	196	205	223	242	251	260
	8	190	200	209	229	248	258	267
Reading	2	145	154	163	180	198	207	216
	3	157	165	174	192	209	218	227
	4	167	175	184	201	218	226	234
	5	174	183	191	208	224	232	241
	6	180	188	196	212	229	237	245
	7	184	192	200	216	233	241	249
	8	188	196	204	220	237	245	253
Language Usage	2	147	155	164	180	197	206	214
	3	160	168	176	192	208	216	224
	4	170	177	185	201	216	224	231
	5	177	184	192	207	222	229	236
	6	181	189	196	211	226	233	241
	7	185	193	200	215	230	237	244
	8	189	196	204	218	233	241	248

2.1.2. Off-Grade Student Ability

For the off-grade student ability values, six true RIT points (R1 – R6) were obtained from empirical analysis of extant data for each grade and content area. True RITs for off-grade students were defined by 1 grade down and 1 grade up. Table 2.3 presents the true RIT points for each grade and content area. R1, R2, and R3 represent the lower grade RITs, and R4, R5, and R6 represent the higher grade RITs. There were no on-grade student abilities in this condition. For simulation conditions with off-grade simulees, a total of 3,000 test events (500 × 6 = 3,000) were simulated for each grade and content area.

Table 2.3. True RITs for Off-Grade Student Ability

Test	Grade	1 Grade Down			1 Grade Up		
		R1	R2	R3	R4	R5	R6
Mathematics	2	133	138	142	216	220	224
	3	151	159	162	228	232	236
	4	164	168	172	239	243	247
	5	174	176	179	248	249	251
	6	180	181	182	254	257	260
	7	183	184	185	262	264	267
	8	187	189	190	268	269	270
Reading	2	134	138	142	218	223	227
	3	145	150	154	229	232	234
	4	157	161	165	236	238	241
	5	167	170	172	242	244	245
	6	174	176	179	246	248	249
	7	180	182	183	250	252	253
	8	184	186	187	254	255	256
Language Usage	2	134	138	142	216	220	224
	3	155	157	159	226	228	231
	4	160	165	169	232	234	236
	5	170	173	176	237	239	241
	6	177	179	180	242	243	244
	7	181	183	184	245	247	248
	8	185	186	188	249	250	251

2.2. Statistical Analyses

Measurement precision was evaluated for each condition with the following statistics:

- *Test information*. The information provided by an observed test. A large amount of information means a student with the same ability as the true RIT can be estimated with precision. Relative efficiency (RE) was computed to show the degree of additional test information that an all-grade item pool provided over an on-grade item pool and a ±1 grade item pool. RE > 1 means the all-grade item pool was more efficient, whereas RE < 1 means the alternative item pool was more efficient. Relative efficiency provides an indication of how many items are needed to achieve comparable amount of information. For example, a relative efficiency of 1.5 indicates that a 50% increase in the number of items on a test produced from the on-grade pool is needed to achieve the same information as test produced from the all-grade pool.

- *SEM.* The SEM was computed for each simulee as the inverse of the square root of test information. For MAP Growth tests, SEM varies due to different test lengths. An SEM less than 3.0 was observed in typical mathematics and language usage tests (50 items), and an SEM less than 3.4 was observed in typical reading tests (40 items).

- *Bias and RMSE*. Bias and root mean square error (RMSE) summarize the difference between true RIT and the final estimated RIT score. The equations to compute these statistics are as follows:

$$\text{Bias} = N^{-1} \sum_{i=1}^{N} (\theta_i - \hat{\theta}_i) \quad (1)$$

$$\text{RMSE} = \sqrt{N^{-1} \sum_{i=1}^{N} (\theta_i - \hat{\theta}_i)^2} \quad (2)$$

  where θ_i is the true RIT, and $\hat{\theta}_i$ is the estimated RIT score.

The item pool was also evaluated for each condition with the following variables:

- *Item exposure rate.* Item exposure rate based on item grade and content strand was calculated as the percentage of total items administered in each condition.
- *Pool utilization.* The number and percent of items administered were calculated and provide an indication of the degree to which the item pool was used in each condition.

Finally, content balancing (i.e., content coverage) was examined against the expectation that items are distributed approximately equally across instructional areas within each test. Content coverage was examined by calculating the percentage of an instructional area in each test that had balanced, slightly unbalanced, or extremely unbalanced item counts, with consideration of power selection (i.e., items are selected at the beginning of the test without regard to instructional area), as shown in Table 2.4.

Table 2.4. Flag Criteria for Content Balancing

Content Area	Total #Items	#Items in an Instructional Area	Balanced	Slightly Unbalanced	Extremely Unbalanced
Mathematics	50	4	9 ≤ n ≤ 17	5 < n < 9 or 17 < n < 22	n ≤ 5 or n ≥ 22
Reading	40	5	5 ≤ n ≤ 13	3 < n < 5 or 13 < n < 16	n ≤ 3 or n ≥ 16
Language Usage	50	3	13 ≤ n ≤ 21	8 < n < 13 or 21 < n < 26	n ≤ 8 or n ≥ 26

3. Results

3.1. Measurement Precision

Appendix A presents the SEM and relative efficiency results, and Appendix B presents the bias and RMSE results. The results varied by content area, so separate summaries are provided below.

3.1.1. SEM and Relative Efficiency

3.1.1.1. Mathematics

As shown in Table A.1, SEMs for on-grade simulees are consistently larger when using an on-grade mathematics item pool. For on-grade simulees exposed to an on-grade item pool, the range of SEM was large (2.96 – 5.20). Many values were larger than 3, and the largest values occurred at the low end of the scale. The average SEM for the on-grade pool is 3.16, which is above the desirable value for precise measurement (i.e., SEM < 3). In the worst case (Grade 8, RIT = 190), the on-grade test would need to be 2.8 times longer than a test from the all-grade pool to achieve the same amount of information.

SEMs for the ±1-grade and all-grade item pools are lower than those for the on-grade pool as evidenced by the average SEM values below three. Moreover, the ±1-grade and all-grade pools had similar SEMs. Relative efficiency values also show that the on-grade pool is consistently less efficient than the all-grade pool when given to on-grade students. The ±1-grade pool tends to be as efficient as the all-grade pool for on-grade students.

As grade level increases, the relative efficiency of the on-grade pool decreases at the low end of the scale. It decreases in a similar way for the ±1 grade pool but to a lesser extent. This pattern suggests that the on-grade pool lacks items at the low end of the scale, resulting in less precise measurement there.

SEMs were uniformly larger for off-grade simulees than they were for on-grade simulees, regardless of the type of item pool, but the increase was largest for the on-grade pool (see the right panel of Table A.1). In fact, the SEM ranged from 2.98 to 5.8 for the on-grade pool, but it only ranged from 2.95 to 3.39 for the all-grade pool. For off-grade simulees, the all-grade pool was 1.01 to 3.42 times more efficient than the on-grade pool for off-grade simulees, and it was 1 to 1.37 times more efficient than the ±1-grade pool. In almost all cases, the all-grade pool had SEMs less than 3. The opposite was true for the on-grade and ±1-grade pools, where most SEMs were larger than 3.

3.1.1.2. Reading

As shown in Table A.2, SEMs for reading were generally higher than they were in mathematics for both on-grade and off-grade simulees. The all-grade item pool had the lowest SEMs, followed by the ±1-grade pool and the on-grade pool, but all SEMs were larger than 3. The all-grade pool was the only pool that had an average SEM of 3.4 (the operational stopping rule for SEM), and it had the smallest range of SEMs (3.34 to 3.87). The ±1-grade pool also had a slightly higher average SEM (3.41), and wider range of values (3.32 to 4.14). The on-grade pool had the largest average SEM with a value of 3.59. It also had the widest range of values (3.33 to 5.06). For each pool, values larger than 3.4 typically occurred at extreme ends of the scale, particularly for the on-grade pool. It was usually the low end of the scale that resulted in SEMs larger than 3.4 for the on-grade pool.

Relative efficiencies also show that the ±1-grade pool produced comparable information to the all-grade pool for on-grade simulees. In some cases, the ±1 grade pool (e.g., Grade 5, RIT = 183) and the on-grade pool was more efficient than the all-grade pool (e.g., Grade 6, RIT = 212). However, the all-grade item pool was generally more efficient than the ±1-grade pool and on-grade pool with efficiencies as high as 1.27 and 1.92, respectively, when compared to the all-grade pool for on-grade simulees. These values indicate that some ±1-grade tests would have to be about 1.3 times longer than an all-grade test. Similarly, some on-grade tests would have to be almost twice as long as an all-grade test to yield the same amount of information.

For off-grade simulees (right panel of Table A.2), SEMs were consistently larger than they were for on-grade simulees regardless of the item pool. Across all grades and RIT scores, the average SEM was 3.50, 3.87, and 4.64 for the all-grade, ±1-grade, and on-grade item pools, respectively. The range of SEMs was lowest for the all-grade pool (3.33 – 5.52), and the ±1-grade pool had a narrower range (3.34 – 6.00) than the on-grade pool (3.44 – 6.67). Relative efficiencies followed a similar pattern. The all-grade pool produced the most information for off-grade simulees, the ±1-grade pool resulted in slightly less information, and the on-grade pool produced substantially less information than the all-grade pool. On average, a ±1-grade test would need to be 1.2 times longer than an all-grade test, and an on-grade test would need to be 1.66 times longer than an all-grade test.

3.1.1.3. Language Usage

As shown in Table A.3, SEMs for language usage pools were lower than they were for reading., All pools performed well for on-grade simulees, but the lowest SEMs occurred for the all-grade item pool. In a few cases, the on-grade (Grade 5, RIT = 184) and ±1-grade (Grade 6, RIT = 221) pools were more efficient than the all-grade pool. The all-grade item pool had an average SEM less than 3 with a range of 2.96 to 3.65 points. The mean and range were larger for the ±1-grade and even larger for the on-grade pool than they were for the all-grade pool. In terms of information, the ±1-grade pool was nearly as efficient as the all-grade pool for on-grade simulees. Like mathematics, language usage showed a trend of increasing SEMs at the low end of the scale as the grade level increased, particularly for the on-grade pool.

For off-grade simulees (right panel of Table A.3), SEMs were generally larger for all item pools than they were for on-grade students. The pattern of performance was similar to mathematics and reading. The all-grade item pool had lower SEMs across all grades and RIT levels (mean SEM = 3.14). The ±1-grade pool had the next lowest SEMs (mean SEM = 3.29), and the on-grade pool consistently yielded the largest SEMs (mean SEM = 3.87). The ±1-grade pool was almost as efficient as the all-grade pool with an average relative efficiency of 1.09. The on-grade pool had an average relative efficiency of 1.48 with the all-grade pool, indicating that an on-grade test would need to be almost 50% longer to yield the same information as an all-grade test.

3.1.2. Bias and RMSE

3.1.2.1. Mathematics

As shown in Table B.1, biases for on-grade simulees are consistently larger when using an on-grade item pool (ranging from -0.4 to 1). The RMSEs for the on-grade pool are also relatively large with an average value of 2.53. Biases for the ±1-grade and all-grade item pools are lower than those for the on-grade pool, ranging from -0.33 to 0.36 and -0.31 to 0.24, respectively. The average RMSE also dropped to 2.39 for the ±1-grade item pool and to 2.36 for the all-grade pool. Similarly, for off-grade simulees (right panel of Table B.1), biases for the on-grade item

pool are larger (ranging from -0.41 to 1.23). The RMSEs for the on-grade pool are also larger with an average value of 2.88. Biases for the ±1-grade and all-grade item pools ranged from -0.3 to 0.51 and -0.31 to 0.18, respectively. The average RMSE also decreased to 2.5 for the ±1-grade item pool and 2.4 for the all-grade pool.

3.1.2.2. Reading

As shown in Table B.2, estimation accuracy for reading was generally not as good as mathematics for both on-grade and off-grade simulees. Biases for on-grade simulees are consistently larger when using an on-grade item pool (ranging from -0.92 to 0.62). The RMSEs for the on-grade pool are also relatively large with an average value of 2.89. Biases for the ±1-grade and all-grade item pools are lower than those for the on-grade pool, ranging from -0.4 to 0.44 and -0.33 to 0.37, respectively. The average RMSE also dropped to 2.76 for the ±1-grade item pool and 2.71 for the all-grade pool. Similarly, for off-grade simulees (right panel of Table B.2), biases for the on-grade item pool are larger, ranging from -1.94 to 1.89. The RMSEs for the on-grade pool are also larger with an average value of 3.81. Biases for the ±1-grade and all-grade item pools ranged from -0.81 to 1.26 and -0.39 to 1.19, respectively. The average RMSE also decreased to 3.12 for the ±1-grade item pool and 2.8 for the all-grade pool.

3.1.2.3. Language Usage

As shown in Table B.3, estimation accuracy for language usage tests were better than reading. For on-grade simulees, biases are larger when using an on-grade item pool (ranging from -0.3 to 0.74). The RMSEs for the on-grade pool are also relatively large with an average value of 2.53. Biases for the ±1-grade and all-grade item pools are lower than those for the on-grade pool, ranging from -0.4 to 0.35 and -0.25 to 0.27, respectively. The average RMSE also dropped to 2.42 for the ±1-grade item pool and 2.39 for the all-grade pool. Similarly, for off-grade simulees (right panel of Table B.3), biases for the on-grade item pool are larger, ranging from -0.96 to 2.66. The RMSEs for the on-grade pool are also larger with an average value of 3.15. Biases for the ±1-grade and all-grade item pools ranged from -0.27 to 1.96 and -0.25 to 1.43, respectively. The average RMSE also decreased to 2.66 for the ±1-grade item pool and 2.51 for the all-grade pool.

3.2. Item Exposure Rates

Appendix C presents the item exposure rates by item pool and grade[3]. For on-grade simulees (Tables C.1 – C.3), tests using the all-grade item pool had items spread out across item grades. In most conditions with on-grade simulees, the modal grade of the items administered to simulees was one to two levels away from the simulee's actual grade, while in some conditions, the modal grade went up or down four levels. For example, in mathematics Grade 7, the modal grade went to Grade 3, Grade 4, Grade 6, and Grade 9 for various RIT levels. In reading Grade 2, the modal grade went through Grades 2–6. In language usage Grade 8 tests, the modal grade went to Grade 4, Grade 6, Grades 9–10, and Grades 11–12.

For tests with off-grade simulees (Tables C.4 – C.6), the modal grade was less spread out and mostly focused in two grades that could be as much as eight grade levels apart. For example, in mathematics Grade 6, the modal grade went down to Grade 3 when testing students with lower Grade 5 ability (RIT 180–182) and then went up to Grade 9 when testing students with higher Grade 7 ability (RIT 254–260). In reading Grade 2, the modal grade stayed in Grade 2 when testing students with lower Grade 1 ability and then went up to Grade 6 when testing students

[3] Item exposure rates by content strand are available in separate files.

with higher Grade 3 ability. In language usage Grade 3, the modal grade went down to Grade 1 when testing students with lower Grade 2 ability and then went up to Grades 9–10 when testing students with higher Grade 4 ability.

For simulations with on-grade simulees, tests using the ±1-grade item pool mainly borrowed items from the lower or upper grade to support students with relatively lower or higher ability. For example, in reading Grade 2, more than 50% items were from Grade 1 to support students with lower Grade 2 ability, and more than 80% items were from Grade 3 to support students with higher Grade 2 ability. This pattern is more prominent in simulations with off-grade simulees. Tests using the ±1-grade item pool borrowed a larger number of items from the lower and upper grades than they did on-grade to support students with lower or upper grade ability. For example, in reading Grade 5, more than 98% items were from Grade 4 when testing students with lower Grade 4 ability, and more than 92% items were from Grade 6 when testing students with higher Grade 6 ability. However, it is less obvious in mathematics tests in Grade 2, Grade 4, Grade 5, and Grade 6, and reading and language usage tests in Grade 8 for simulations with both on-grade and off-grade simulees.

3.3. Pool Utilization

Appendix D presents the pool utilization results. In mathematics tests, the degree of item use is higher with the on-grade item pool (mean=53.7%) than for the ±1-grade item pool (mean=46.3%) or all-grade item pool (mean=39.5%). For mathematics, 80% of items were from the on-grade item pool in 11 conditions. Reading results follow a similar pattern, with an average of 48.4% using the on-grade item pool versus 43.3% with the ±1-grade item pool and 37.1% with the all-grade item pool. For reading, 80% of items were from the on-grade item pool in seven conditions. Language usage tests have the highest item use rate, with an average of 60.8% using the on-grade item pool versus 53.9% with the ±1-grade item pool and 42.3% with the all-grade item pool. For language usage, 80% of items were from the on-grade item pool in 13 conditions.

Compared to simulations with on-grade simulees, item use rates are relatively lower in simulations with off-grade simulees. As shown in Tables D.4 – D.6, on average, mathematics tests have similar rates with different types of item pools (23.6% with the on-grade item pool, 21.1% with the ±1 grade item pool, and 25.1% with the all-grade item pool). Similarly, reading tests have similar use rates across item pools (13.1% with the on-grade item pool, 12.1% with the ±1 grade item pool, and 15.7% with the all-grade item pool). Likewise, language usage tests have 23.9% with the on-grade item pool, 21.6% with the ±1 grade item pool, and 25.2% with the all-grade item pool.

3.4. Content Balancing

Appendix E presents the content balancing results (i.e., how well the items were distributed within each test across instructional areas) by percentage of each instructional area that has balanced, slightly unbalanced, and extremely unbalanced item counts.
For simulations with on-grade simulees, most instructional areas (> 96%) are balanced in mathematics tests with different item pools. Grade 5, Grade 6, and Grade 8 show unbalanced results. As shown in Figure E.1, Grade 5 items are extremely unbalanced along the instructional areas. The pool is shallow in “Operations and Algebraic Thinking” and “Geometry”. For the Grade 6 item pool shown in Figure E.2, the reason for unbalanced instructional areas may be that most items are associated with “The Real and Complex Number Systems.” As shown in Figure E.3, the Grade 8 item pool is shallow in “The Real and Complex Number Systems” and

“Statistics and Probability.” For reading, most instructional areas (> 97%) are balanced in tests with different item pools. Grades 6–8 show unbalanced results at the low end, especially with the on-grade and ±1-grade item pools. As shown in Figures E.3 – E.6, except for “Vocabulary,” other instructional areas are relatively weak in the RIT range of 180–200. Content balancing were greatly improved with all-grade item pool.

For simulations with off-grade simulees, most instructional areas (> 96%) are balanced in mathematics tests with different item pools. However, the Grade 5 item pool is unbalanced when administered to students with higher Grade 6 ability, and the Grade 6 item pool is unbalanced when administered to students with lower Grade 5 ability. For reading, on average (assuming students with off-grade ability take the grade-level reading tests), using the on-grade item pool caused content balancing to drop from 99.8% to 82.3%. Unbalanced instructional areas occurred when administering the following item pools:

- Grade 2 item pool to students with lower Grade 1 ability or students with higher Grade 3 ability
- Grade 4 item pool to students with lower Grade 3 ability
- Grade 6 item pool to students with higher Grade 5 ability
- Grade 7 item pool to students with lower Grade 6 ability
- Grade- 8 item pool to students with lower Grade 7 ability

Language usage tests achieved the perfect results for simulations with both on- and off-grade simulees, and all three instructional areas were balanced in all test events.

4. Discussion

The results in this study indicate that by using the on-grade or ±1-grade item pool instead of the all-grade item pool, measurement precision, item exposure rate, pool utilization, and content balancing are diminished. Specifically, tests using the on-grade item pool may not be able to provide precise measurement, especially at the low end of the scale. Mathematics and language usage show a trend of increasing SEMs at the low end of the ability spectrum as the grade level increases, particularly for the on-grade item pool. SEMs for reading are large at the extreme ends of the scale for the on-grade item pool and at the low end for the ±1-grade pool.

The all-grade item pool is most efficient, followed by the ±1-grade pool. The on-grade item pool is the least efficient. To achieve the same amount of information, a test using the on-grade item pool would need to be longer than a test using the ±1-grade or all-grade item pool. However, relative efficiencies for reading suggest that the ±1-grade pool provided comparable information to the all-grade item pool for on-grade simulees. In a few cases, the ±1-grade item pool was more efficient than the all-grade pool. Results for language usage also show that the ±1-grade item pool was almost as efficient as the all-grade pool for both on-grade and off-grade simulees.

Testing students with off-grade ability using on-grade item pools results in diminished measurement precision. SEMs are uniformly larger and relative efficiencies are higher, especially for on-grade item pool, indicating that test length would need to be increased to a greater extent to yield the same information as using an all-grade item pool.

On the positive side, the current on-grade item pools have an adequate number of items to support tests restricted to on-grade items. Almost all on-grade item pools contain more than 10 times as many items as the test length, except for language usage Grade 2 and Grade 8 item pools. Further enhancement needs to focus on item distribution for providing more effective measurement.

Tests produced from item pools with grade-level restrictions had less information and fewer items per instructional area. However, these limitations can be overcome by the following during development of on-grade items:

- Adding more items to the low and high ends of each grade's ability spectrum, especially to those flagged in this study
- Adding items particularly to those weak instructional areas (if content balancing is part of the test design)

Once more grade-level items are developed and field tested, it is recommended to have new tests go through a standardized test validation procedure. Given test specifications (e.g., number of administrations, longitudinal constraint), we can provide additional suggestions.

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Appendix A: SEM and Reliability Efficiency

Table A.1. SEM and Relative Efficiency—Mathematics

	On-Grade Simulee						Off-Grade Simulee					
		SEM			Relative Efficiency			SEM			Relative Efficiency	
Grade	True RIT	On-Grade	±1-Grade	All-Grade	RE1	RE2	True RIT	On-Grade	±1-Grade	All-Grade	RE1	RE2
	151	2.98	2.96	2.95	1.02	1.00	133	4.24	4.06	3.39	1.49	1.37
	159	2.96	2.96	2.96	1.00	1.00	138	3.62	3.45	3.10	1.33	1.22
	167	2.96	2.96	2.96	1.00	1.00	142	3.27	3.19	2.99	1.19	1.13
2	183	2.97	2.97	2.97	1.00	1.00	216	3.22	2.99	2.97	1.17	1.02
	199	2.98	2.96	2.97	1.01	1.00	220	3.40	3.02	2.96	1.31	1.04
	207	3.04	2.96	2.97	1.05	1.00	224	3.69	3.07	2.96	1.51	1.07
	215	3.18	2.98	2.96	1.15	1.01	–	–	–	–	–	–
	164	3.11	2.97	2.96	1.10	1.00	151	3.84	2.97	2.95	1.65	1.02
	172	3.00	2.96	2.97	1.02	1.00	159	3.27	2.96	2.96	1.22	1.00
	179	3.00	2.97	2.97	1.02	1.00	162	3.17	2.97	2.97	1.14	1.00
3	194	3.06	2.96	2.96	1.07	1.00	228	3.35	2.97	2.96	1.28	1.00
	209	3.17	2.96	2.97	1.14	1.00	232	3.41	2.98	2.97	1.32	1.01
	216	3.22	2.97	2.96	1.19	1.01	236	3.51	3.00	2.96	1.39	1.02
	224	3.29	2.97	2.96	1.23	1.00	–	–	–	–	–	–
	174	3.13	2.96	2.96	1.12	1.00	164	3.55	3.02	2.96	1.42	1.04
	181	3.02	2.96	2.97	1.03	1.00	168	3.32	2.98	2.97	1.25	1.01
	189	2.97	2.97	2.97	1.00	1.00	172	3.18	2.96	2.97	1.15	1.00
4	205	2.96	2.96	2.97	1.00	1.00	239	3.07	3.00	2.97	1.07	1.02
	220	2.96	2.97	2.96	1.00	1.00	243	3.21	3.09	2.96	1.17	1.09
	228	2.97	2.97	2.96	1.00	1.00	247	3.42	3.21	2.98	1.30	1.15
	236	3.00	2.98	2.96	1.03	1.01	–	–	–	–	–	–
	180	3.57	3.01	2.97	1.43	1.03	174	4.05	3.09	2.96	1.82	1.09
	188	3.23	2.97	2.97	1.18	1.00	176	3.89	3.05	2.97	1.68	1.06
	197	3.04	2.96	2.96	1.05	1.00	179	3.65	3.02	2.97	1.50	1.04
5	214	3.01	2.96	2.97	1.03	1.00	248	3.65	3.11	2.99	1.49	1.09
	230	3.13	2.97	2.96	1.11	1.00	249	3.69	3.13	2.99	1.51	1.09
	239	3.35	2.98	2.96	1.27	1.01	251	3.76	3.18	3.01	1.54	1.11
	247	3.62	3.09	2.98	1.46	1.07	–	–	–	–	–	–
	183	3.21	3.10	2.96	1.17	1.09	180	3.34	3.18	2.96	1.26	1.15
	192	3.02	2.99	2.97	1.03	1.02	181	3.30	3.15	2.96	1.23	1.13
	200	2.97	2.97	2.96	1.01	1.01	182	3.26	3.12	2.96	1.20	1.10
6	218	2.97	2.96	2.96	1.01	1.00	254	3.08	2.96	2.96	1.08	1.00
	234	2.96	2.96	2.96	1.00	1.00	257	3.15	2.96	2.96	1.13	1.00
	243	2.96	2.97	2.97	1.00	1.00	260	3.27	2.97	2.96	1.21	1.00
	251	3.01	2.97	2.97	1.03	1.00	–	–	–	–	–	–
	187	3.76	3.06	2.96	1.60	1.07	183	4.09	3.16	2.96	1.86	1.13
	196	3.42	2.99	2.96	1.33	1.02	184	3.99	3.13	2.97	1.77	1.11
	205	3.11	2.97	2.97	1.10	1.00	185	3.89	3.11	2.97	1.69	1.09
7	223	2.96	2.96	2.96	1.00	1.00	262	2.98	2.96	2.96	1.01	1.00
	242	2.96	2.97	2.97	1.00	1.00	264	3.01	2.96	2.96	1.03	1.00
	251	2.97	2.96	2.97	1.00	1.00	267	3.07	2.98	2.96	1.07	1.01
	260	2.97	2.96	2.96	1.00	1.00	–	–	–	–	–	–
	190	5.20	3.30	2.96	2.83	1.23	187	5.80	3.44	2.96	3.42	1.33
	200	3.93	3.05	2.96	1.73	1.06	189	5.40	3.33	2.96	3.00	1.26
	209	3.42	2.98	2.97	1.32	1.01	190	5.15	3.30	2.97	2.78	1.23
8	229	2.97	2.96	2.96	1.00	1.00	268	3.17	2.96	2.96	1.14	1.00
	248	2.96	2.96	2.96	1.00	1.00	269	3.20	2.96	2.96	1.16	1.00
	258	2.99	2.96	2.97	1.02	1.00	270	3.23	2.96	2.96	1.18	1.00
	267	3.14	2.96	2.96	1.12	1.00	–	–	–	–	–	–
	Min.	2.96	2.96	2.95	1.00	1.00	–	2.98	2.96	2.95	1.01	1.00
	Max.	5.20	3.30	2.98	2.83	1.23	–	5.80	4.06	3.39	3.42	1.37
	Mean	3.16	2.98	2.96	1.14	1.01	–	3.59	3.10	2.98	1.46	1.08
	SD	0.37	0.06	0.00	0.30	0.04	–	0.62	0.20	0.07	0.51	0.09

Note. Test information is $100/SEM^2$.

Table A.2. SEM and Relative Efficiency—Reading

	On-Grade Simulee						Off-Grade Simulee					
		SEM			Relative Efficiency			SEM			Relative Efficiency	
Grade	True RIT	On-Grade	±1-Grade	All-Grade	RE1	RE2	True RIT	On-Grade	±1-Grade	All-Grade	RE1	RE2
	145	4.44	4.14	3.87	1.3	1.13	134	6.67	6.00	5.52	1.39	1.16
	154	3.79	3.57	3.47	1.19	1.05	138	5.67	5.15	4.77	1.34	1.15
	163	3.56	3.37	3.36	1.12	1.01	142	4.93	4.49	4.17	1.34	1.14
2	180	3.39	3.35	3.34	1.03	1.00	218	4.64	3.47	3.34	1.84	1.08
	198	3.41	3.34	3.34	1.04	1.00	223	5.69	3.82	3.35	2.54	1.27
	207	3.65	3.34	3.34	1.18	1.00	227	6.52	4.26	3.34	3.27	1.56
	216	4.35	3.41	3.34	1.63	1.04	–	–	–	–	–	–
	157	3.76	3.48	3.42	1.18	1.03	145	5.72	4.24	3.87	1.91	1.18
	165	3.38	3.36	3.35	1.01	1.01	150	4.63	3.79	3.59	1.54	1.11
	174	3.33	3.34	3.34	1.00	1.00	154	3.99	3.58	3.47	1.28	1.06
3	192	3.34	3.35	3.35	0.99	1.00	229	4.64	3.73	3.34	1.77	1.23
	209	3.34	3.34	3.35	0.99	0.99	232	5.15	4.04	3.34	2.13	1.40
	218	3.47	3.34	3.34	1.07	1.00	234	5.65	4.24	3.34	2.47	1.54
	227	4.27	3.58	3.34	1.56	1.14	–	–	–	–	–	–
	167	3.4	3.32	3.34	1.03	0.99	157	3.97	3.62	3.42	1.30	1.10
	175	3.33	3.34	3.35	0.99	1.00	161	3.62	3.42	3.37	1.14	1.03
	184	3.35	3.35	3.35	1.00	1.00	165	3.44	3.34	3.35	1.05	1.00
4	201	3.34	3.34	3.34	1.00	1.00	236	4.67	4.03	3.36	1.77	1.38
	218	3.35	3.33	3.34	1.00	0.99	238	5.13	4.33	3.38	2.05	1.54
	226	3.55	3.37	3.34	1.12	1.01	241	5.88	4.83	3.47	2.48	1.78
	234	4.35	3.83	3.34	1.61	1.27	–	–	–	–	–	–
	174	3.47	3.33	3.34	1.08	1.00	167	3.88	3.39	3.34	1.31	1.03
	183	3.36	3.34	3.35	1.01	0.99	170	3.63	3.35	3.34	1.17	1.00
	181	3.35	3.34	3.35	1.00	1.00	172	3.55	3.34	3.34	1.12	1.00
5	208	3.33	3.34	3.35	0.99	1.00	242	5.41	3.64	3.5	2.08	1.06
	224	3.35	3.34	3.34	1.01	1.00	244	5.93	3.81	3.61	2.29	1.10
	232	3.73	3.34	3.34	1.22	1.00	245	6.18	3.91	3.69	2.40	1.10
	241	5.06	3.57	3.46	1.92	1.05	–	–	–	–	–	–
	180	3.80	3.37	3.34	1.26	1.02	174	4.51	3.47	3.33	1.71	1.08
	188	3.40	3.34	3.35	1.03	1.00	176	4.22	3.42	3.33	1.52	1.05
	196	3.33	3.34	3.34	0.99	1.00	179	3.85	3.38	3.34	1.30	1.02
6	212	3.34	3.34	3.35	0.99	0.99	246	4.04	3.59	3.34	1.40	1.14
	229	3.34	3.34	3.35	0.99	1.00	248	4.25	3.76	3.34	1.55	1.24
	237	3.41	3.34	3.34	1.03	1.00	249	4.43	3.84	3.35	1.63	1.29
	245	3.91	3.53	3.34	1.32	1.10	–	–	–	–	–	–
	184	3.89	3.51	3.34	1.31	1.09	180	4.37	3.78	3.34	1.60	1.25
	192	3.40	3.34	3.35	1.03	0.99	182	4.08	3.62	3.34	1.42	1.16
	200	3.33	3.34	3.35	0.99	0.99	183	3.99	3.55	3.34	1.37	1.12
7	216	3.34	3.34	3.34	1.00	1.00	250	4.15	3.62	3.35	1.47	1.15
	233	3.34	3.34	3.34	1.00	1.00	252	4.38	3.75	3.37	1.59	1.21
	241	3.43	3.34	3.34	1.05	1.00	253	4.57	3.89	3.4	1.68	1.28
	249	3.99	3.54	3.35	1.38	1.10	–	–	–	–	–	–
	188	3.84	3.53	3.35	1.28	1.11	184	4.30	3.83	3.34	1.56	1.28
	196	3.45	3.33	3.34	1.06	0.99	186	4.01	3.68	3.34	1.40	1.19
	204	3.35	3.34	3.35	1.00	0.99	187	3.95	3.62	3.34	1.35	1.15
8	220	3.34	3.34	3.34	1.00	1.00	254	4.09	3.84	3.42	1.37	1.23
	237	3.33	3.33	3.35	0.99	0.99	255	4.24	3.95	3.44	1.45	1.28
	245	3.43	3.36	3.34	1.05	1.01	256	4.41	4.04	3.48	1.52	1.30
	253	3.98	3.74	3.4	1.32	1.19	–	–	–	–	–	–
	Min.	3.33	3.32	3.34	0.99	0.99	–	3.44	3.34	3.33	1.05	1.00
	Max.	5.06	4.14	3.87	1.92	1.27	–	6.67	6.00	5.52	3.27	1.78
	Mean	3.59	3.41	3.36	1.13	1.03	–	4.64	3.87	3.50	1.66	1.20
	SD	0.38	0.15	0.08	0.20	0.06	–	0.84	0.52	0.41	0.47	0.17

Note. Test information is $100/SEM^2$.

Table A.3. SEM and Relative Efficiency—Language Usage

	On-Grade Simulee						Off-Grade Simulee					
		SEM			Relative Efficiency			SEM			Relative Efficiency	
Grade	True RIT	On-Grade	±1-Grade	All-Grade	RE1	RE2	True RIT	On-Grade	±1-Grade	All-Grade	RE1	RE2
	147	4.55	3.77	3.65	1.47	1.06	134	7.97	6.54	6.14	1.69	1.12
	155	3.53	3.17	3.12	1.26	1.03	138	6.89	5.38	5.17	1.66	1.06
	164	3.1	2.98	2.97	1.09	1.01	142	5.70	4.54	4.32	1.58	1.08
2	180	2.96	2.96	2.96	1.00	1.00	216	3.67	3.00	2.97	1.49	1.02
	197	2.97	2.96	2.96	1.01	1.00	220	4.12	3.08	2.97	1.82	1.08
	206	3.09	2.96	2.96	1.08	1.00	224	4.83	3.22	2.97	2.39	1.17
	214	3.45	2.98	2.96	1.33	1.01	–	–	–	–	–	–
	160	3.12	3.03	3.01	1.07	1.01	155	3.47	3.24	3.14	1.20	1.06
	168	2.95	2.95	2.96	0.99	1.00	157	3.30	3.13	3.07	1.14	1.04
	176	2.96	2.96	2.96	1.00	1.00	159	3.17	3.05	3.03	1.08	1.01
3	192	2.96	2.96	2.96	1.00	1.00	226	3.30	3.03	2.96	1.23	1.04
	208	2.96	2.96	2.97	0.99	1.00	228	3.41	3.06	2.96	1.31	1.07
	216	2.99	2.96	2.96	1.02	1.00	231	3.60	3.15	2.96	1.45	1.13
	224	3.21	3.00	2.97	1.17	1.02	–	–	–	–	–	–
	170	2.99	2.95	2.96	1.02	1.00	160	3.48	3.06	3.01	1.30	1.03
	177	2.96	2.96	2.96	1.00	1.00	165	3.13	2.96	2.97	1.11	1.00
	185	2.97	2.97	2.97	1.00	1.00	169	3.01	2.95	2.95	1.04	1.00
4	201	2.96	2.96	2.96	1.00	1.00	232	3.37	3.01	2.96	1.28	1.03
	216	2.96	2.96	2.96	1.00	1.00	234	3.52	3.06	2.96	1.39	1.06
	224	3.02	2.97	2.97	1.03	1.00	236	3.75	3.11	2.96	1.55	1.10
	231	3.29	3.00	2.96	1.22	1.03	–	–	–	–	–	–
	177	3.13	2.96	2.96	1.11	1.00	170	3.68	2.99	2.96	1.50	1.02
	184	2.95	2.96	2.96	0.99	1.00	173	3.41	2.96	2.96	1.30	1.00
	192	2.96	2.96	2.96	1.00	1.00	176	3.17	2.96	2.96	1.14	1.00
5	207	2.96	2.96	2.96	1.00	1.00	237	3.47	2.98	2.96	1.36	1.01
	222	2.98	2.96	2.97	1.01	1.00	239	3.66	3.01	2.96	1.49	1.04
	229	3.07	2.96	2.96	1.07	1.00	241	3.92	3.08	2.96	1.68	1.08
	236	3.39	2.97	2.96	1.30	1.01	–	–	–	–	–	–
	181	3.47	3.00	2.96	1.35	1.02	177	3.88	3.10	2.96	1.65	1.09
	189	3.06	2.95	2.96	1.07	1.00	179	3.66	3.03	2.96	1.49	1.04
	196	2.98	2.97	2.97	1.01	1.00	180	3.55	3.01	2.96	1.41	1.03
6	211	2.96	2.96	2.97	1.00	0.99	242	3.40	3.07	2.96	1.30	1.08
	226	2.97	2.96	2.97	1.00	1.00	243	3.46	3.11	2.96	1.34	1.09
	233	3.03	2.96	2.96	1.04	1.00	244	3.55	3.15	2.96	1.40	1.12
	241	3.32	3.03	2.96	1.25	1.05	–	–	–	–	–	–
	185	3.56	3.13	2.96	1.42	1.11	181	3.89	3.30	2.96	1.68	1.23
	193	3.14	2.98	2.96	1.12	1.01	183	3.69	3.20	2.96	1.53	1.16
	200	2.99	2.97	2.96	1.02	1.00	184	3.63	3.17	2.96	1.48	1.14
7	215	2.96	2.96	2.97	0.99	1.00	245	3.38	3.11	2.97	1.28	1.09
	230	2.96	2.97	2.96	1.00	1.00	247	3.58	3.18	3.00	1.39	1.12
	237	3.03	2.98	2.96	1.05	1.01	248	3.68	3.22	3.02	1.44	1.13
	244	3.32	3.07	2.97	1.24	1.07	–	–	–	–	–	–
	189	4.02	3.22	2.96	1.76	1.18	185	4.72	3.44	2.96	2.28	1.34
	196	3.36	3.00	2.96	1.27	1.03	186	4.51	3.38	2.96	2.12	1.29
	204	3.05	2.96	2.96	1.06	1.00	188	4.13	3.27	2.97	1.84	1.20
8	218	2.97	2.96	2.97	1.01	1.00	249	3.56	3.21	3.05	1.34	1.10
	233	3.05	2.96	2.96	1.06	1.00	250	3.67	3.28	3.07	1.39	1.13
	241	3.13	2.97	2.96	1.12	1.01	251	3.77	3.34	3.12	1.43	1.13
	248	3.48	3.16	3.02	1.31	1.09	–	–	–	–	–	–
	Min.	2.95	2.95	2.96	0.99	0.99	–	3.01	2.95	2.95	1.04	1.00
	Max.	4.55	3.77	3.65	1.76	1.18	–	7.97	6.54	6.14	2.39	1.34
	Mean	3.15	3.00	2.98	1.11	1.01	–	3.87	3.29	3.14	1.48	1.09
	SD	0.30	0.13	0.10	0.16	0.03	–	0.95	0.67	0.62	0.29	0.08

Note. Test information is $100/SEM^2$.

Appendix B: Bias and RMSE

Table B.1. Bias and RMSE—Mathematics

	On-Grade Simulee						Off-Grade Simulee					
		Bias			RMSE			Bias			RMSE	
Grade	True RIT	On-Grade	±1-Grade	All-Grade	On-Grade	±1-Grade	All-Grade	True RIT	On-Grade	±1-Grade	All-Grade	On-Grade	±1-Grade	All-Grade
	151	-0.12	-0.04	-0.14	2.35	2.35	2.22	133	0.41	0.51	0.07	3.48	3.34	2.61
	159	-0.10	0.05	-0.11	2.32	2.26	2.27	138	0.21	0.07	0.00	2.99	2.78	2.55
	167	-0.10	0.06	0.07	2.39	2.34	2.43	142	-0.20	0.12	-0.15	2.60	2.78	2.41
2	183	0.01	0.12	0.00	2.56	2.37	2.38	246	-0.13	-0.11	-0.10	2.57	2.47	2.42
	199	-0.10	-0.01	0.01	2.40	2.30	2.25	220	-0.31	0.08	0.07	2.57	2.34	2.32
	207	-0.34	0.36	-0.12	2.44	2.47	2.54	224	-0.36	-0.14	0.13	2.92	2.53	2.40
	215	-0.03	-0.04	0.08	2.52	2.45	2.44	–	–	–	–	–	–	–
	164	-0.14	-0.01	-0.31	2.46	2.36	2.33	151	0.39	-0.25	-0.14	2.97	2.29	2.22
	172	0.00	0.07	0.09	2.22	2.36	2.38	159	0.09	-0.14	-0.11	2.50	2.38	2.27
	179	-0.17	-0.21	0.12	2.37	2.25	2.52	162	-0.07	-0.13	0.08	2.47	2.54	2.27
3	194	-0.25	0.02	-0.06	2.49	2.38	2.37	228	-0.04	-0.04	-0.02	2.70	2.36	2.42
	209	0.09	-0.11	-0.11	2.66	2.50	2.43	232	0.02	-0.07	0.08	2.63	2.47	2.31
	216	0.01	-0.10	-0.15	2.50	2.20	2.20	236	-0.17	-0.02	-0.04	2.76	2.34	2.42
	224	0.23	-0.04	-0.08	2.69	2.41	2.51	–	–	–	–	–	–	–
	174	0.00	0.16	-0.02	2.49	2.26	2.36	164	0.02	0.10	-0.31	2.86	2.57	2.33
	181	-0.25	0.03	0.15	2.49	2.41	2.20	168	0.05	0.15	-0.14	2.77	2.45	2.52
	189	-0.03	-0.06	0.01	2.40	2.34	2.33	172	0.16	-0.04	0.05	2.54	2.51	2.36
4	205	-0.18	0.01	-0.23	2.40	2.31	2.39	239	-0.18	0.07	0.08	2.36	2.42	2.24
	220	0.14	0.00	0.07	2.40	2.33	2.32	243	-0.34	-0.20	0.18	2.56	2.46	2.30
	228	-0.03	-0.08	-0.09	2.39	2.51	2.34	247	-0.08	-0.09	-0.04	2.58	2.57	2.29
	236	-0.25	-0.15	-0.06	2.21	2.33	2.30	–	–	–	–	–	–	–
	180	0.12	0.14	-0.19	2.87	2.36	2.46	174	0.41	0.20	-0.02	3.25	2.34	2.36
	188	0.13	-0.02	0.00	2.76	2.31	2.37	176	0.57	-0.14	0.13	3.18	2.34	2.38
	197	0.06	-0.02	-0.06	2.41	2.45	2.35	179	0.39	0.19	0.12	2.84	2.43	2.52
5	214	0.29	-0.14	0.12	2.33	2.46	2.36	248	-0.41	-0.20	0.06	2.97	2.48	2.57
	230	-0.15	0.06	0.00	2.59	2.49	2.42	249	-0.35	-0.16	-0.01	3.05	2.41	2.37
	239	-0.25	0.08	0.14	2.83	2.53	2.35	251	0.04	-0.04	-0.08	3.10	2.57	2.46
	247	-0.40	0.00	-0.15	3.03	2.55	2.46	–	–	–	–	–	–	–
	183	-0.17	-0.05	0.05	2.54	2.46	2.59	180	-0.08	0.02	-0.22	2.58	2.58	2.41
	192	-0.09	0.06	-0.06	2.47	2.51	2.24	181	0.12	0.04	0.00	2.66	2.46	2.40
	200	-0.20	0.15	-0.29	2.35	2.28	2.37	182	-0.07	-0.20	-0.03	2.64	2.44	2.42
6	218	-0.02	-0.24	-0.12	2.40	2.48	2.29	254	-0.31	-0.30	0.10	2.33	2.35	2.53
	234	0.19	-0.03	-0.05	2.31	2.45	2.43	257	-0.01	-0.01	-0.12	2.51	2.31	2.41
	243	0.02	0.04	-0.16	2.29	2.40	2.27	260	0.06	-0.09	-0.01	2.65	2.40	2.41
	251	-0.10	-0.02	0.22	2.17	2.35	2.28	–	–	–	–	–	–	–
	187	0.35	-0.03	-0.02	2.87	2.42	2.33	183	0.56	0.06	0.05	3.39	2.47	2.59
	196	0.13	0.00	-0.26	2.76	2.33	2.43	184	0.34	0.15	-0.13	3.42	2.49	2.38
	205	0.06	-0.16	0.24	2.49	2.38	2.40	185	0.16	0.13	-0.04	2.85	2.56	2.55
7	223	-0.13	-0.25	-0.24	2.32	2.36	2.46	262	-0.05	-0.20	-0.06	2.38	2.47	2.46
	242	0.13	0.16	0.23	2.37	2.39	2.33	264	0.10	0.09	0.06	2.45	2.43	2.29
	251	0.12	0.01	0.01	2.38	2.43	2.36	267	-0.08	0.13	-0.01	2.53	2.42	2.39
	260	-0.03	-0.15	-0.05	2.40	2.37	2.40	–	–	–	–	–	–	–
	190	1.00	-0.22	-0.10	4.37	2.83	2.46	187	1.23	0.09	-0.02	4.69	2.91	2.33
	200	0.29	-0.11	0.11	3.18	2.49	2.23	189	1.03	-0.19	-0.02	4.47	2.75	2.43
	209	0.16	-0.33	-0.03	2.79	2.40	2.33	190	0.67	-0.04	-0.02	4.38	2.70	2.48
8	229	-0.15	-0.07	0.16	2.35	2.38	2.33	268	-0.10	0.03	-0.10	2.56	2.52	2.38
	248	0.00	0.04	-0.01	2.55	2.28	2.39	269	-0.12	-0.04	-0.02	2.52	2.27	2.37
	258	0.03	-0.15	-0.18	2.35	2.34	2.30	270	-0.10	0.25	-0.02	2.56	2.46	2.35
	267	-0.02	-0.21	-0.17	2.38	2.29	2.33	–	–	–	–	–	–	–
	Min.	-0.40	-0.33	-0.31	2.17	2.20	2.20	–	-0.41	-0.30	-0.31	2.33	2.27	2.22
	Max.	1.00	0.36	0.24	4.37	2.83	2.59	–	1.23	0.51	0.18	4.69	3.34	2.61
	Mean	-0.01	-0.03	-0.04	2.53	2.39	2.36	–	0.08	-0.01	-0.02	2.88	2.50	2.40
	SD	0.22	0.13	0.13	0.34	0.10	0.09	–	0.36	0.16	0.10	0.54	0.19	0.10

Table B.2. Bias and RMSE—Reading

	On-Grade Simulee							Off-Grade Simulee						
		Bias			RMSE				Bias			RMSE		
Grade	True RIT	On-Grade	±1-Grade	All-Grade	On-Grade	±1-Grade	All-Grade	True RIT	On-Grade	±1-Grade	All-Grade	On-Grade	±1-Grade	All-Grade
	145	0.19	0.44	-0.04	3.57	3.36	3.19	134	1.89	1.26	1.19	5.77	4.82	4.58
	154	-0.24	0.18	-0.29	3.20	3.00	2.72	138	1.13	1.03	0.92	4.91	4.17	3.93
	163	-0.04	0.21	0.26	2.93	2.70	2.93	142	0.95	0.62	0.39	4.11	3.69	3.27
2	180	0.18	0.20	-0.33	2.85	2.72	2.53	218	-0.51	0.03	-0.21	3.63	2.73	2.72
	198	0.14	0.10	-0.29	2.77	2.70	2.64	223	-1.44	-0.38	0.11	4.87	3.05	2.50
	207	-0.18	-0.03	-0.10	3.04	2.47	2.67	227	-1.31	-0.41	0.13	5.24	3.08	2.75
	216	-0.18	-0.05	-0.13	3.34	2.56	2.63	–	–	–	–	–	–	–
	157	0.62	-0.04	0.12	2.97	2.83	2.97	145	1.26	0.33	-0.04	4.67	3.48	3.19
	165	0.18	0.20	-0.21	2.68	2.79	2.74	150	0.69	0.19	0.05	4.05	3.01	2.80
	174	-0.21	0.12	-0.21	2.53	2.83	2.73	154	0.02	0.12	0.09	3.23	2.99	2.63
3	192	0.20	-0.02	0.22	2.72	2.72	2.56	229	-0.69	-0.48	0.15	3.93	2.89	2.49
	209	0.29	0.23	-0.14	2.55	2.76	2.69	232	-0.68	-0.53	0.25	4.15	3.29	2.64
	218	0.13	-0.34	0.05	2.84	2.80	2.81	234	-0.92	-0.30	-0.12	4.57	3.28	2.62
	227	-0.44	-0.31	0.04	3.32	2.84	2.68	–	–	–	–	–	–	–
	167	0.17	-0.17	0.06	2.89	2.62	2.63	157	0.49	0.13	0.12	3.41	3.06	2.97
	175	-0.08	-0.01	-0.01	2.64	2.59	2.78	161	0.20	0.01	-0.37	2.91	2.57	2.67
	184	0.19	0.03	-0.27	2.64	2.67	2.48	165	0.06	-0.12	0.02	2.65	2.67	2.73
4	201	-0.38	0.05	-0.20	2.81	2.79	2.60	236	-0.65	-0.38	0.10	3.66	3.25	2.72
	218	-0.19	0.28	-0.32	2.76	2.70	2.74	238	-1.25	-0.65	0.04	4.27	3.56	2.67
	226	-0.16	0.12	-0.02	2.94	2.74	2.61	241	-1.86	-0.79	-0.26	4.78	3.82	2.86
	234	-0.75	-0.40	0.05	3.44	3.19	2.74	–	–	–	–	–	–	–
	174	0.05	-0.11	-0.10	2.89	2.73	2.53	167	0.38	0.06	0.06	3.25	2.73	2.63
	183	0.12	0.28	-0.11	2.74	2.52	2.70	170	0.00	-0.01	-0.23	2.97	2.74	2.65
	181	-0.23	0.04	0.08	2.57	2.74	2.63	172	0.24	0.02	-0.07	2.81	2.67	2.55
5	208	-0.10	0.10	-0.17	2.71	2.87	2.67	242	-1.51	-0.09	-0.23	4.51	3.01	2.61
	224	-0.11	0.01	0.19	2.72	2.63	2.72	244	-1.73	-0.28	-0.13	4.88	3.18	2.96
	232	-0.31	0.02	0.15	3.05	2.72	2.63	245	-1.94	-0.40	-0.39	5.17	3.21	3.16
	241	-0.92	-0.01	0.21	4.12	2.93	2.75	–	–	–	–	–	–	–
	180	0.52	0.23	0.02	3.23	2.70	2.81	174	0.68	0.35	-0.03	3.83	2.79	2.62
	188	0.17	0.04	0.11	2.64	2.81	2.74	176	0.57	-0.13	-0.14	3.45	2.90	2.69
	196	-0.05	-0.18	0.01	2.59	2.58	2.73	179	0.22	-0.09	0.06	3.03	2.77	2.65
6	212	-0.22	0.07	0.08	2.76	2.83	2.66	246	-0.45	0.01	0.12	3.21	2.88	2.57
	229	-0.01	0.03	-0.11	2.71	2.63	2.71	248	-0.34	-0.37	0.23	3.31	3.07	2.55
	237	0.19	0.10	-0.03	2.83	2.76	2.73	249	-0.41	-0.37	0.01	3.79	3.01	2.78
	245	-0.11	0.04	0.07	3.36	2.86	2.72	–	–	–	–	–	–	–
	184	0.30	-0.02	0.02	3.15	2.84	2.71	180	0.42	0.27	0.02	3.75	3.05	2.81
	192	-0.05	0.07	0.03	2.75	2.61	2.71	182	0.19	0.04	0.04	3.36	2.82	2.64
	200	-0.16	0.07	0.05	2.71	2.75	2.69	183	0.43	-0.09	-0.08	3.23	2.90	2.80
7	216	-0.03	0.18	0.26	2.61	2.70	2.79	250	-0.72	-0.51	0.01	3.33	2.97	2.66
	233	-0.01	0.29	0.08	2.48	2.78	2.88	252	-0.46	-0.27	0.18	3.39	2.89	2.56
	241	-0.10	-0.14	-0.12	2.80	2.82	2.47	253	-0.61	-0.81	-0.10	3.76	3.25	2.65
	249	-0.40	-0.06	0.09	3.00	2.80	2.63	–	–	–	–	–	–	–
	188	0.06	-0.12	-0.09	3.16	2.83	2.93	184	0.26	0.01	0.02	3.62	3.02	2.71
	196	0.11	-0.04	0.37	2.63	2.63	2.83	186	0.05	0.20	-0.02	2.99	3.02	2.67
	204	-0.17	-0.07	0.05	2.79	2.74	2.50	187	0.34	0.25	-0.03	3.25	3.11	2.73
8	220	0.01	0.15	-0.04	2.60	2.84	2.57	254	-0.44	-0.27	-0.14	3.30	3.07	2.73
	237	0.11	0.07	0.12	2.63	2.74	2.74	255	-0.76	-0.48	0.05	3.48	3.24	2.64
	245	-0.48	0.12	-0.17	2.75	2.72	2.75	256	-1.00	-0.31	-0.23	3.68	3.13	2.64
	253	-0.44	-0.17	-0.09	3.19	2.97	2.78	–	–	–	–	–	–	–
	Min.	-0.92	-0.40	-0.33	2.48	2.47	2.47	–	-1.94	-0.81	-0.39	2.65	2.57	2.49
	Max.	0.62	0.44	0.37	4.12	3.36	3.19	–	1.89	1.26	1.19	5.77	4.82	4.58
	Mean	-0.06	0.04	-0.02	2.89	2.76	2.71	–	-0.22	-0.08	0.04	3.81	3.12	2.80
	SD	0.28	0.17	0.16	0.32	0.15	0.13	–	0.87	0.42	0.28	0.75	0.42	0.38

Table B.3. Bias and RMSE—Language Usage

	On-Grade Simulee						Off-Grade Simulee					
		Bias			RMSE			Bias			RMSE	
Grade	True RIT	On-Grade	±1-Grade	All-Grade	On-Grade	±1-Grade	All-Grade	True RIT	On-Grade	±1-Grade	All-Grade	On-Grade	±1-Grade	All-Grade
	147	0.74	0.35	0.19	3.68	3.06	2.87	134	2.66	1.96	1.43	6.56	5.44	5.12
	155	0.38	0.03	-0.19	2.77	2.44	2.48	138	2.40	1.07	1.15	5.95	4.61	4.29
	164	-0.09	-0.01	-0.10	2.35	2.36	2.43	142	1.35	0.76	0.53	4.64	3.77	3.42
2	180	-0.22	-0.24	0.06	2.27	2.38	2.35	216	-0.57	-0.22	0.11	3.04	2.38	2.35
	197	-0.02	0.05	0.10	2.38	2.34	2.37	220	-0.45	-0.09	-0.08	3.44	2.49	2.28
	206	0.03	0.04	0.26	2.32	2.44	2.19	224	-0.96	-0.18	-0.25	3.92	2.55	2.49
	214	-0.03	-0.30	-0.12	2.65	2.43	2.41	–	–	–	–	–	–	–
	160	0.07	0.13	0.14	2.51	2.61	2.48	155	0.22	0.17	0.17	2.75	2.68	2.38
	168	-0.21	-0.06	0.27	2.38	2.43	2.41	157	0.11	0.10	-0.19	2.70	2.53	2.53
	176	0.07	-0.07	0.14	2.35	2.38	2.35	159	-0.15	-0.16	0.20	2.77	2.47	2.51
3	192	0.05	-0.19	0.10	2.46	2.28	2.46	226	-0.04	-0.02	-0.10	2.44	2.46	2.38
	208	0.03	0.12	-0.06	2.33	2.40	2.44	228	-0.15	-0.03	0.16	2.73	2.35	2.34
	216	0.16	0.09	-0.12	2.36	2.51	2.40	231	-0.07	-0.23	0.06	3.01	2.61	2.28
	224	0.05	0.09	-0.16	2.63	2.40	2.37	–	–	–	–	–	–	–
	170	-0.06	-0.07	0.02	2.30	2.44	2.27	160	0.35	-0.04	0.14	2.89	2.42	2.48
	177	-0.16	0.09	-0.03	2.35	2.61	2.36	165	-0.06	0.01	0.01	2.60	2.32	2.35
	185	-0.02	0.10	0.20	2.34	2.35	2.46	169	0.03	-0.03	-0.16	2.38	2.26	2.33
4	201	0.10	0.11	0.20	2.40	2.36	2.34	232	-0.33	0.37	0.10	2.69	2.39	2.42
	216	0.12	0.03	0.06	2.32	2.41	2.50	234	-0.20	-0.21	0.22	2.90	2.48	2.31
	224	-0.29	-0.01	-0.25	2.32	2.39	2.49	236	-0.64	-0.19	0.19	2.94	2.45	2.28
	231	-0.16	-0.12	-0.06	2.57	2.37	2.50	–	–	–	–	–	–	–
	177	0.17	-0.19	0.26	2.63	2.35	2.38	170	0.34	0.04	0.02	3.12	2.52	2.27
	184	0.12	-0.02	0.00	2.31	2.35	2.36	173	0.44	-0.08	0.08	2.92	2.42	2.33
	192	-0.17	0.09	-0.12	2.46	2.41	2.36	176	-0.03	-0.02	0.14	2.66	2.34	2.35
5	207	0.13	-0.03	0.03	2.36	2.33	2.37	237	-0.11	-0.03	0.12	2.55	2.47	2.27
	222	0.03	-0.03	-0.20	2.32	2.56	2.50	239	-0.25	0.10	-0.03	2.80	2.53	2.35
	229	-0.26	-0.01	0.14	2.48	2.30	2.38	241	-0.69	-0.16	0.06	3.14	2.37	2.36
	236	-0.02	-0.11	0.05	2.67	2.47	2.32	–	–	–	–	–	–	–
	181	0.09	0.26	-0.16	2.75	2.49	2.45	177	0.35	0.27	0.26	3.17	2.68	2.38
	189	-0.25	0.03	0.18	2.54	2.30	2.20	179	0.26	0.07	-0.05	3.04	2.34	2.40
	196	-0.02	-0.18	-0.03	2.41	2.34	2.30	180	0.05	-0.12	0.01	2.87	2.47	2.36
6	211	0.11	-0.17	-0.06	2.65	2.32	2.30	242	-0.53	-0.08	0.03	2.72	2.62	2.27
	226	-0.01	0.20	-0.05	2.40	2.44	2.38	243	-0.40	-0.19	-0.02	2.70	2.37	2.36
	233	-0.30	-0.16	-0.19	2.39	2.29	2.45	244	-0.45	-0.08	0.15	2.81	2.53	2.24
	241	-0.29	0.04	-0.03	2.69	2.46	2.38	–	–	–	–	–	–	–
	185	0.33	0.08	-0.15	3.05	2.42	2.37	181	0.55	0.18	-0.16	3.22	2.62	2.45
	193	0.20	-0.15	-0.03	2.5-7	2.39	2.47	183	0.22	0.14	0.03	2.87	2.55	2.22
	200	0.29	0.09	-0.12	2.35	2.42	2.37	184	0.37	0.30	-0.09	3.02	2.49	2.28
7	215	-0.14	-0.03	-0.04	2.36	2.32	2.31	245	-0.04	-0.18	0.17	2.61	2.49	2.39
	230	0.11	0.08	-0.07	2.46	2.38	2.47	247	-0.29	0.05	-0.04	2.96	2.51	2.29
	237	-0.03	0.17	-0.05	2.40	2.33	2.29	248	-0.37	0.20	0.04	2.92	2.56	2.48
	244	-0.10	-0.01	0.15	2.75	2.38	2.43	–	–	–	–	–	–	–
	189	0.35	0.15	-0.10	3.28	2.64	2.42	185	0.83	0.33	-0.15	3.94	2.80	2.37
	196	0.00	-0.08	0.19	2.93	2.35	2.27	186	0.64	0.26	0.00	3.81	2.92	2.43
	204	-0.08	-0.40	0.19	2.40	2.39	2.37	188	0.17	0.21	-0.10	3.30	2.54	2.35
8	218	-0.07	-0.03	-0.04	2.35	2.48	2.33	249	-0.21	-0.05	-0.13	2.76	2.57	2.62
	233	-0.13	0.15	-0.14	2.48	2.26	2.40	250	-0.46	-0.27	0.02	3.05	2.60	2.41
	241	0.07	0.06	0.06	2.50	2.29	2.36	251	-0.47	-0.03	0.00	3.07	2.78	2.49
	248	-0.18	-0.15	0.02	2.82	2.73	2.41	–	–	–	–	–	–	–
	Min.	-0.30	-0.40	-0.25	2.27	2.26	2.19	–	-0.96	-0.27	-0.25	2.38	2.26	2.22
	Max.	0.74	0.35	0.27	3.68	3.06	2.87	–	2.66	1.96	1.43	6.56	5.44	5.12
	Mean	0.01	0.00	0.01	2.53	2.42	2.39	–	0.08	0.09	0.10	3.15	2.66	2.51
	SD	0.20	0.14	0.14	0.27	0.13	0.10	–	0.71	0.39	0.31	0.83	0.59	0.54

Appendix C: Item Exposure Rates

Table C.1. Item Exposure Rates for On-Grade Simulees—Mathematics

SG	True RIT	±1 Grade Item Pool									All-Grade Item Pool									
		G1	G2	G3	G4	G5	G6	G7	G8	G9	K	G1	G2	G3	G4	G5	G6	G7	G8	G9
	151	19.6	72.4	8.0	–	–	–	–	–	–	37.1	21.1	37.2	4.1	0.5	–	–	–	–	–
	159	17.9	68.6	13.5	–	–	–	–	–	–	27.5	27.4	36.9	6.5	1.6	0.2	–	–	–	–
	167	17.7	60.5	21.9	–	–	–	–	–	–	19.8	29.0	36.1	11.0	3.6	0.5	0.1	–	–	–
2	183	13.9	38.7	47.4	–	–	–	–	–	–	12.6	14.3	27.2	29.3	12.2	3.6	1.0	–	–	–
	199	9.2	29.5	61.4	–	–	–	–	–	–	3.3	6.7	14.3	29.9	32.4	10.9	2.2	0.2	–	–
	207	6.7	27.0	66.3	–	–	–	–	–	–	0.7	4.4	8.8	22.6	40.3	15.2	6.5	1.3	0.1	0.1
	215	3.1	27.4	69.5	–	–	–	–	–	–	0.1	1.6	4.9	14.4	39.1	19.6	15.9	3.7	0.3	0.3
	164	–	78.5	16.4	5.1	–	–	–	–	–	22.4	29.0	36.3	9.1	2.7	0.5	–	–	–	–
	172	–	65.1	25.8	9.1	–	–	–	–	–	16.4	26.0	35.3	15.7	5.3	1.0	0.3	–	–	–
	179	–	49.0	36.4	14.6	–	–	–	–	–	14.2	18.4	31.0	24.9	8.7	2.3	0.5	–	–	–
3	194	–	25.0	39.9	35.1	–	–	–	–	–	6.0	7.7	18.5	31.7	25.9	8.5	1.7	0.1	–	–
	209	–	10.7	29.4	60.0	–	–	–	–	–	0.4	3.8	7.8	20.7	40.6	16.3	8.3	1.8	0.1	0.2
	216	–	6.8	24.4	68.8	–	–	–	–	–	0.1	1.3	4.3	13.5	38.4	20.3	17.4	4.0	0.5	0.4
	224	–	4.1	23.8	72.1	–	–	–	–	–	–	0.2	2.1	9.4	28.8	23.7	26.0	7.1	1.9	0.9
	174	–	–	69.5	27.3	3.2	–	–	–	–	15.1	23.9	34.4	18.7	6.1	1.3	0.4	–	–	–
	181	–	–	65.8	28.9	5.3	–	–	–	–	13.7	16.3	29.5	26.9	10.3	2.7	0.7	–	–	–
	189	–	–	56.9	34.3	8.8	–	–	–	–	9.3	9.6	22.1	32.4	19.3	6.0	1.3	–	–	–
4	205	–	–	33.2	49.2	17.6	–	–	–	–	1.0	5.0	10.2	24.6	38.9	14.4	5.0	0.9	–	0.1
	220	–	–	16.4	53.8	29.8	–	–	–	–	–	0.5	3.1	11.1	33.6	22.1	22.7	5.4	0.9	0.6
	228	–	–	12.5	48.7	38.9	–	–	–	–	–	0.1	1.4	7.8	24.4	24.9	28.0	8.7	3.3	1.4
	236	–	–	7.3	47.1	45.6	–	–	–	–	–	–	0.4	4.6	18.5	25.3	29.5	12.9	6.0	3.0
	180	–	–	–	81.6	13.0	5.5	–	–	–	13.9	17.0	30.3	25.9	9.7	2.7	0.6	–	–	–
	188	–	–	–	77.0	15.6	7.4	–	–	–	10.0	10.3	23.2	31.9	17.9	5.6	1.2	–	–	–
	197	–	–	–	74.8	16.8	8.5	–	–	–	4.4	6.9	15.9	30.7	30.5	9.6	1.9	0.1	–	–
5	214	–	–	–	63.3	24.6	12.1	–	–	–	0.1	1.9	5.5	15.8	39.4	19.1	14.3	3.4	0.3	0.3
	230	–	–	–	45.7	34.9	19.5	–	–	–	–	–	1.2	6.9	22.9	25.2	28.2	9.7	4.1	1.7
	239	–	–	–	37.2	39.0	23.8	–	–	–	–	–	0.2	3.6	16.4	25.7	29.8	14.1	6.5	3.6
	247	–	–	–	33.3	40.5	26.3	–	–	–	–	–	–	1.9	10.4	25.5	31.1	19.7	6.6	4.8
	183	–	–	–	–	20.4	64.5	15.1	–	–	–	–	–	61.9	17.0	6.8	10.8	2.4	0.5	0.6
	192	–	–	–	–	18.4	64.4	17.2	–	–	–	–	–	48.2	22.1	7.3	13.4	4.8	1.6	2.7
	200	–	–	–	–	16.6	62.2	21.2	–	–	–	–	–	33.0	27.2	9.5	15.8	8.5	2.7	3.3
6	218	–	–	–	–	14.3	47.1	38.6	–	–	–	–	–	8.9	20.1	12.1	21.7	19.2	9.2	8.7
	234	–	–	–	–	10.7	45.2	44.1	–	–	–	–	–	2.2	5.9	10.9	23.3	22.7	14.0	21.0
	243	–	–	–	–	7.7	40.6	51.7	–	–	–	–	–	0.7	2.5	8.0	19.1	21.9	16.2	31.7
	251	–	–	–	–	5.2	32.1	62.7	–	–	–	–	–	0.3	0.8	5.4	13.5	18.7	16.9	44.4
	187	–	–	–	–	–	78.5	16.7	4.9	–	–	–	–	56.8	18.6	7.0	12.0	3.1	1.0	1.4
	196	–	–	–	–	–	74.3	18.8	6.9	–	–	–	–	40.3	25.3	8.0	14.6	6.7	2.2	3.0
	205	–	–	–	–	–	64.9	26.4	8.7	–	–	–	–	25.6	27.7	10.6	17.2	11.6	3.8	3.6
7	223	–	–	–	–	–	44.9	36.0	19.1	–	–	–	–	5.6	13.8	13.3	23.7	20.3	11.1	12.3
	242	–	–	–	–	–	32.8	36.7	30.5	–	–	–	–	0.9	2.6	8.9	19.5	21.8	16.3	30.0
	251	–	–	–	–	–	23.8	36.1	40.1	–	–	–	–	0.3	0.9	4.9	13.5	18.6	17.1	44.7
	260	–	–	–	–	–	13.6	39.9	46.5	–	–	–	–	0.1	0.2	1.5	6.1	15.6	14.0	62.5
	190	–	–	–	–	–	–	54.2	22.2	23.7	–	–	–	52.2	20.7	7.1	12.6	4.1	1.4	2.0
	200	–	–	–	–	–	–	54.6	22.6	22.8	–	–	–	33.7	27.3	9.3	15.2	8.6	2.7	3.2
	209	–	–	–	–	–	–	60.0	22.1	17.8	–	–	–	18.8	26.0	11.6	18.2	15.0	5.6	4.7
8	229	–	–	–	–	–	–	56.6	25.6	17.9	–	–	–	3.7	9.0	12.5	23.9	21.3	13.3	16.3
	248	–	–	–	–	–	–	33.3	25.7	41.0	–	–	–	0.4	1.4	6.3	15.9	19.8	17.0	39.2
	258	–	–	–	–	–	–	20.7	18.8	60.6	–	–	–	0.1	0.4	2.2	7.4	15.7	14.3	59.9
	267	–	–	–	–	–	–	14.2	12.5	73.3	–	–	–	–	0.1	0.5	1.6	12.8	11.3	73.7
	Min.	3.1	4.1	7.3	5.1	3.2	5.5	14.2	4.9	17.8	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.1	0.1
	Max.	19.6	78.5	69.5	81.6	45.6	78.5	62.7	46.5	73.3	37.1	29.0	37.2	61.9	40.6	25.7	31.1	22.7	17.1	73.7
	Mean	12.6	40.2	35.5	46.0	20.3	37.7	35.9	21.9	36.7	10.8	11.8	17.7	18.3	17.3	10.3	12.9	10.4	6.8	14.3
	SD	6.3	25.4	21.6	22.4	12.9	23.4	16.2	11.9	22.4	10.1	10.0	13.8	16.1	13.0	7.9	9.7	7.6	6.2	20.9

Notes: SG refers to simulee grade. Modal exposure rate for each RIT level and grade is shown in red.

Table C.2. Item Exposure Rates for On-Grade Simulees—Reading

SG	True RIT	±1 Grade Item Pool									All-Grade Item Pool										
		G1	G2	G3	G4	G5	G6	G7	G8	G9	K	G1	G2	G3	G4	G5	G6	G7	G8	G9-10	G11-12
	145	51.3	35.8	13.0	–	–	–	–	–	–	21.2	26.4	36.1	10.0	6.3	–	–	–	–	–	–
	159	50.6	36.1	13.3	–	–	–	–	–	–	20.0	25.3	36.2	11.9	6.6	0.1	–	–	–	–	–
	167	49.4	34.4	16.2	–	–	–	–	–	–	14.7	24.1	33.0	17.9	9.4	0.9	–	–	–	–	–
2	183	17.5	35.1	47.5	–	–	–	–	–	–	1.7	7.1	22.3	33.4	24.9	9.6	1.0	0.2	–	–	–
	199	1.6	17.3	81.0	–	–	–	–	–	–	–	0.5	5.8	22.4	29.9	22.0	13.0	4.6	1.7	0.1	0.1
	207	0.3	12.9	86.8	–	–	–	–	–	–	–	0.1	1.7	10.4	22.8	25.7	23.2	11.2	4.3	0.5	0.2
	215	–	13.3	86.7	–	–	–	–	–	–	–	–	0.6	3.8	11.3	19.3	32.4	18.9	11.2	2.0	0.6
	164	–	72.7	16.0	11.4	–	–	–	–	–	19.2	25.5	35.1	13.1	7.0	0.2	–	–	–	–	–
	172	–	67.7	18.6	13.7	–	–	–	–	–	12.2	23.3	31.7	20.2	11.1	1.4	–	–	–	–	–
	179	–	54.7	28.3	17.0	–	–	–	–	–	4.9	14.0	27.2	28.8	19.2	5.7	0.2	–	–	–	–
3	194	–	21.0	43.9	35.1	–	–	–	–	–	0.1	1.6	11.4	30.8	29.6	16.9	6.7	2.1	0.7	–	–
	209	–	4.6	26.6	68.8	–	–	–	–	–	–	0.1	1.4	8.4	20.0	24.7	25.7	13.4	5.4	0.7	0.3
	216	–	4.4	17.9	77.7	–	–	–	–	–	–	–	0.5	2.7	9.6	17.3	33.6	20.1	12.9	2.6	0.8
	224	–	4.4	16.0	79.7	–	–	–	–	–	–	–	0.2	0.5	4.5	7.6	32.7	26.0	22.2	5.4	0.9
	174	–	–	80.5	19.3	0.2	–	–	–	–	10.3	22.2	30.8	22.3	12.2	2.2	–	–	–	–	–
	181	–	–	78.0	20.9	1.1	–	–	–	–	4.4	13.4	26.3	29.6	19.9	6.0	0.3	0.1	–	–	–
	189	–	–	69.6	25.7	4.7	–	–	–	–	0.8	4.5	19.4	34.2	26.5	11.7	2.2	0.5	0.2	–	–
4	205	–	–	36.3	39.0	24.7	–	–	–	–	–	0.3	4.0	18.0	28.7	24.2	15.9	6.4	2.2	0.2	0.1
	220	–	–	9.5	32.6	57.9	–	–	–	–	–	–	0.5	2.7	9.0	16.8	33.9	20.4	13.3	2.6	0.9
	228	–	–	4.2	30.0	65.7	–	–	–	–	–	–	0.2	0.6	4.7	8.3	33.1	25.6	21.8	4.8	0.9
	236	–	–	3.3	29.4	67.3	–	–	–	–	–	–	–	0.1	3.5	2.6	27.3	29.4	28.8	7.7	0.5
	180	–	–	–	98.1	1.5	0.5	–	–	–	4.7	14.3	26.9	29.3	18.6	6.0	0.3	–	–	–	–
	188	–	–	–	92.0	5.4	2.6	–	–	–	1.1	5.2	20.5	33.8	26.3	11.0	1.6	0.4	0.1	–	–
	197	–	–	–	80.0	11.6	8.4	–	–	–	0.1	1.8	12.3	31.4	29.9	16.1	6.1	1.7	0.6	–	–
5	214	–	–	–	39.3	23.6	37.1	–	–	–	–	0.1	1.5	9.3	21.8	25.1	24.5	12.1	4.9	0.6	0.3
	230	–	–	–	8.8	14.3	76.9	–	–	–	–	–	0.3	1.1	5.3	10.8	34.0	24.4	19.1	4.2	0.9
	239	–	–	–	4.9	6.5	88.6	–	–	–	–	–	–	0.2	3.7	3.6	28.8	28.5	27.4	7.1	0.7
	247	–	–	–	3.4	4.1	92.6	–	–	–	–	–	–	–	2.7	0.6	24.2	28.6	32.8	10.7	0.3
	183	–	–	–	–	93.5	3.7	2.8	–	–	–	–	5.6	37.1	41.4	13.7	1.5	0.4	0.1	–	–
	192	–	–	–	–	86.6	9.7	3.7	–	–	–	–	4.6	33.0	36.8	17.6	5.5	1.7	0.5	0.1	0.1
	200	–	–	–	–	73.1	21.4	5.5	–	–	–	–	3.0	23.4	32.0	21.5	12.3	4.8	2.0	0.8	0.3
6	218	–	–	–	–	39.4	41.7	18.9	–	–	–	–	0.6	4.9	12.7	17.5	24.6	15.1	11.6	9.0	4.0
	234	–	–	–	–	7.2	46.4	46.4	–	–	–	–	–	0.2	1.2	2.3	10.7	12.3	22.1	30.6	20.6
	243	–	–	–	–	1.8	38.5	59.8	–	–	–	–	–	–	0.2	0.7	5.2	9.0	19.4	37.1	28.3
	251	–	–	–	–	0.3	33.4	66.4	–	–	–	–	–	–	–	0.2	2.4	5.6	13.9	40.0	37.9
	187	–	–	–	–	–	86.1	12.4	1.6	–	–	–	5.3	35.9	39.3	15.3	2.8	1.0	0.2	0.1	–
	196	–	–	–	–	–	83.2	13.2	3.6	–	–	–	3.7	29.1	34.4	19.5	8.6	3.1	1.2	0.4	0.1
	205	–	–	–	–	–	78.4	13.5	8.1	–	–	–	1.8	17.8	28.9	22.9	16.4	6.9	3.2	1.6	0.5
7	223	–	–	–	–	–	55.0	21.3	23.7	–	–	–	0.4	2.6	8.2	13.7	23.4	16.7	15.5	13.0	6.6
	242	–	–	–	–	–	23.6	26.5	49.9	–	–	–	–	0.1	0.5	1.3	8.0	10.9	20.8	34.0	24.5
	251	–	–	–	–	–	15.6	27.8	56.6	–	–	–	–	–	0.1	0.3	3.7	7.5	16.6	39.2	32.6
	260	–	–	–	–	–	13.4	28.7	57.9	–	–	–	–	–	–	0.1	1.3	3.7	11.9	41.3	41.8
	190	–	–	–	–	–	–	80.7	15.7	3.7	–	–	4.6	32.7	37.1	17.4	5.5	1.9	0.6	0.1	0.1
	200	–	–	–	–	–	–	78.8	17.0	4.2	–	–	2.9	23.8	32.5	21.2	12.4	4.3	2.0	0.8	0.3
	209	–	–	–	–	–	–	73.2	20.5	6.4	–	–	1.3	12.2	23.6	23.0	20.6	10.0	5.2	3.1	1.0
8	229	–	–	–	–	–	–	48.5	34.8	16.7	–	–	0.2	1.3	4.5	8.9	20.1	16.5	19.4	19.1	10.0
	248	–	–	–	–	–	–	27.3	44.9	27.8	–	–	–	–	0.3	0.7	5.5	9.1	19.2	36.9	28.3
	258	–	–	–	–	–	–	24.1	44.3	31.6	–	–	–	–	0.1	0.2	2.5	5.5	14.2	40.3	37.3
	267	–	–	–	–	–	–	23.1	43.1	33.8	–	–	–	–	–	0.1	0.7	1.8	10.3	42.0	45.2
	Min.	0.3	4.4	3.3	3.4	0.2	0.5	2.8	1.6	3.7	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1
	Max.	51.3	72.7	86.8	98.1	93.5	92.6	80.7	57.9	33.8	21.2	26.4	36.2	37.1	41.4	25.7	34.0	29.4	32.8	42.0	45.2
	Mean	28.5	29.6	37.8	39.4	28.1	40.8	33.4	30.1	17.7	8.2	11.0	11.3	16.6	16.5	10.7	13.8	10.3	10.8	12.9	9.9
	SD	6.3	25.4	21.6	22.4	12.9	23.4	16.2	11.9	22.4	10.1	10.0	13.8	16.1	13.0	7.9	9.7	7.6	6.2	20.9	–

Notes: SG refers to simulee grade. Modal exposure rate for each RIT level and grade is shown in red.

Table C.3. Item Exposure Rates for On-Grade Simulees—Language Usage

SG	True RIT	±1 Grade Item Pool									All-Grade Item Pool										
		G1	G2	G3	G4	G5	G6	G7	G8	G9	K	G1	G2	G3	G4	G5	G6	G7	G8	G9-10	G11-12
	145	51.3	35.8	13.0	–	–	–	–	–	–	21.2	26.4	36.1	10.0	6.3	–	–	–	–	–	–
	159	50.6	36.1	13.3	–	–	–	–	–	–	20.0	25.3	36.2	11.9	6.6	0.1	–	–	–	–	–
	167	49.4	34.4	16.2	–	–	–	–	–	–	14.7	24.1	33.0	17.9	9.4	0.9	–	–	–	–	–
2	183	17.5	35.1	47.5	–	–	–	–	–	–	1.7	7.1	22.3	33.4	24.9	9.6	1.0	0.2	–	–	–
	199	1.6	17.3	81.0	–	–	–	–	–	–	–	0.5	5.8	22.4	29.9	22.0	13.0	4.6	1.7	0.1	0.1
	207	0.3	12.9	86.8	–	–	–	–	–	–	–	0.1	1.7	10.4	22.8	25.7	23.2	11.2	4.3	0.5	0.2
	215	–	13.3	86.7	–	–	–	–	–	–	–	–	0.6	3.8	11.3	19.3	32.4	18.9	11.2	2.0	0.6
	164	–	72.7	16.0	11.4	–	–	–	–	–	19.2	25.5	35.1	13.1	7.0	0.2	–	–	–	–	–
	172	–	67.7	18.6	13.7	–	–	–	–	–	12.2	23.3	31.7	20.2	11.1	1.4	–	–	–	–	–
	179	–	54.7	28.3	17.0	–	–	–	–	–	4.9	14.0	27.2	28.8	19.2	5.7	0.2	–	–	–	–
3	194	–	21.0	43.9	35.1	–	–	–	–	–	0.1	1.6	11.4	30.8	29.6	16.9	6.7	2.1	0.7	–	–
	209	–	4.6	26.6	68.8	–	–	–	–	–	–	0.1	1.4	8.4	20.0	24.7	25.7	13.4	5.4	0.7	0.3
	216	–	4.4	17.9	77.7	–	–	–	–	–	–	–	0.5	2.7	9.6	17.3	33.6	20.1	12.9	2.6	0.8
	224	–	4.4	16.0	79.7	–	–	–	–	–	–	–	0.2	0.5	4.5	7.6	32.7	26.0	22.2	5.4	0.9
	174	–	–	80.5	19.3	0.2	–	–	–	–	10.3	22.2	30.8	22.3	12.2	2.2	–	–	–	–	–
	181	–	–	78.0	20.9	1.1	–	–	–	–	4.4	13.4	26.3	29.6	19.9	6.0	0.3	0.1	–	–	–
	189	–	–	69.6	25.7	4.7	–	–	–	–	0.8	4.5	19.4	34.2	26.5	11.7	2.2	0.5	0.2	–	–
4	205	–	–	36.3	39.0	24.7	–	–	–	–	–	0.3	4.0	18.0	28.7	24.2	15.9	6.4	2.2	0.2	0.1
	220	–	–	9.5	32.6	57.9	–	–	–	–	–	–	0.5	2.7	9.0	16.8	33.9	20.4	13.3	2.6	0.9
	228	–	–	4.2	30.0	65.7	–	–	–	–	–	–	0.2	0.6	4.7	8.3	33.1	25.6	21.8	4.8	0.9
	236	–	–	3.3	29.4	67.3	–	–	–	–	–	–	–	0.1	3.5	2.6	27.3	29.4	28.8	7.7	0.5
	180	–	–	–	98.1	1.5	0.5	–	–	–	4.7	14.3	26.9	29.3	18.6	6.0	0.3	–	–	–	–
	188	–	–	–	92.0	5.4	2.6	–	–	–	1.1	5.2	20.5	33.8	26.3	11.0	1.6	0.4	0.1	–	–
	197	–	–	–	80.0	11.6	8.4	–	–	–	0.1	1.8	12.3	31.4	29.9	16.1	6.1	1.7	0.6	–	–
5	214	–	–	–	39.3	23.6	37.1	–	–	–	–	0.1	1.5	9.3	21.8	25.1	24.5	12.1	4.9	0.6	0.3
	230	–	–	–	8.8	14.3	76.9	–	–	–	–	–	0.3	1.1	5.3	10.8	34.0	24.4	19.1	4.2	0.9
	239	–	–	–	4.9	6.5	88.6	–	–	–	–	–	–	0.2	3.7	3.6	28.8	28.5	27.4	7.1	0.7
	247	–	–	–	3.4	4.1	92.6	–	–	–	–	–	–	–	2.7	0.6	24.2	28.6	32.8	10.7	0.3
	183	–	–	–	–	93.5	3.7	2.8	–	–	–	–	5.6	37.1	41.4	13.7	1.5	0.4	0.1	–	–
	192	–	–	–	–	86.6	9.7	3.7	–	–	–	–	4.6	33.0	36.8	17.6	5.5	1.7	0.5	0.1	0.1
	200	–	–	–	–	73.1	21.4	5.5	–	–	–	–	3.0	23.4	32.0	21.5	12.3	4.8	2.0	0.8	0.3
6	218	–	–	–	–	39.4	41.7	18.9	–	–	–	–	0.6	4.9	12.7	17.5	24.6	15.1	11.6	9.0	4.0
	234	–	–	–	–	7.2	46.4	46.4	–	–	–	–	–	0.2	1.2	2.3	10.7	12.3	22.1	30.6	20.6
	243	–	–	–	–	1.8	38.5	59.8	–	–	–	–	–	–	0.2	0.7	5.2	9.0	19.4	37.1	28.3
	251	–	–	–	–	0.3	33.4	66.4	–	–	–	–	–	–	–	0.2	2.4	5.6	13.9	40.0	37.9
	187	–	–	–	–	–	86.1	12.4	1.6	–	–	–	5.3	35.9	39.3	15.3	2.8	1.0	0.2	0.1	–
	196	–	–	–	–	–	83.2	13.2	3.6	–	–	–	3.7	29.1	34.4	19.5	8.6	3.1	1.2	0.4	0.1
	205	–	–	–	–	–	78.4	13.5	8.1	–	–	–	1.8	17.8	28.9	22.9	16.4	6.9	3.2	1.6	0.5
7	223	–	–	–	–	–	55.0	21.3	23.7	–	–	–	0.4	2.6	8.2	13.7	23.4	16.7	15.5	13.0	6.6
	242	–	–	–	–	–	23.6	26.5	49.9	–	–	–	–	0.1	0.5	1.3	8.0	10.9	20.8	34.0	24.5
	251	–	–	–	–	–	15.6	27.8	56.6	–	–	–	–	–	0.1	0.3	3.7	7.5	16.6	39.2	32.6
	260	–	–	–	–	–	13.4	28.7	57.9	–	–	–	–	–	–	0.1	1.3	3.7	11.9	41.3	41.8
	190	–	–	–	–	–	–	80.7	15.7	3.7	–	–	4.6	32.7	37.1	17.4	5.5	1.9	0.6	0.1	0.1
	200	–	–	–	–	–	–	78.8	17.0	4.2	–	–	2.9	23.8	32.5	21.2	12.4	4.3	2.0	0.8	0.3
	209	–	–	–	–	–	–	73.2	20.5	6.4	–	–	1.3	12.2	23.6	23.0	20.6	10.0	5.2	3.1	1.0
8	229	–	–	–	–	–	–	48.5	34.8	16.7	–	–	0.2	1.3	4.5	8.9	20.1	16.5	19.4	19.1	10.0
	248	–	–	–	–	–	–	27.3	44.9	27.8	–	–	–	–	0.3	0.7	5.5	9.1	19.2	36.9	28.3
	258	–	–	–	–	–	–	24.1	44.3	31.6	–	–	–	–	0.1	0.2	2.5	5.5	14.2	40.3	37.3
	267	–	–	–	–	–	–	23.1	43.1	33.8	–	–	–	–	–	0.1	0.7	1.8	10.3	42.0	45.2
	Min.	0.3	4.4	3.3	3.4	0.2	0.5	2.8	1.6	3.7	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1
	Max.	51.3	72.7	86.8	98.1	93.5	92.6	80.7	57.9	33.8	21.2	26.4	36.2	37.1	41.4	25.7	34.0	29.4	32.8	42.0	45.2
	Mean	28.5	29.6	37.8	39.4	28.1	40.8	33.4	30.1	17.7	8.2	11.0	11.3	16.6	16.5	10.7	13.8	10.3	10.8	12.9	9.9
	SD	6.3	25.4	21.6	22.4	12.9	23.4	16.2	11.9	22.4	10.1	10.0	13.8	16.1	13.0	7.9	9.7	7.6	6.2	20.9	–

Notes: SG refers to simulee grade. Modal exposure rate for each RIT level and grade is shown in red.

Table C.4. Item Exposure Rates for Off-Grade Simulees—Mathematics

SG	True RIT	±1 Grade Item Pool									All-Grade Item Pool									
		G1	G2	G3	G4	G5	G6	G7	G8	G9	K	G1	G2	G3	G4	G5	G6	G7	G8	G9
2	133	18.8	76.2	5.0	–	–	–	–	–	–	55.0	9.6	32.5	2.9	–	–	–	–	–	–
	138	19.1	76.0	4.9	–	–	–	–	–	–	53.0	10.9	33.3	2.8	0.1	–	–	–	–	–
	142	19.1	75.8	5.1	–	–	–	–	–	–	49.1	13.3	34.7	2.8	0.1	–	–	–	–	–
	216	2.9	27.3	69.8	–	–	–	–	–	–	0.1	1.1	4.3	13.8	37.8	20.3	17.6	4.1	0.5	0.4
	220	2.4	25.8	71.8	–	–	–	–	–	–	–	0.5	3.1	11.1	33.6	22.1	22.7	5.4	0.9	0.6
	224	2.4	24.0	73.6	–	–	–	–	–	–	–	0.2	2.2	9.3	29.2	23.5	26.0	7.0	1.7	0.9
3	151	–	92.1	7.0	0.9	–	–	–	–	–	37.1	21.1	37.2	4.1	0.5	–	–	–	–	–
	159	–	84.7	12.1	3.2	–	–	–	–	–	27.5	27.4	36.9	6.5	1.6	0.2	–	–	–	–
	162	–	81.1	14.4	4.5	–	–	–	–	–	24.7	28.4	36.5	7.9	2.1	0.3	0.1	–	–	–
	228	–	3.3	23.5	73.3	–	–	–	–	–	–	0.1	1.4	7.8	24.7	24.5	28.1	8.9	3.2	1.5
	232	–	2.0	22.3	75.7	–	–	–	–	–	–	–	0.8	6.0	21.6	25.1	28.6	10.9	4.9	2.0
	236	–	1.3	22.3	76.4	–	–	–	–	–	–	–	0.4	4.5	18.8	25.3	29.0	13.0	6.1	2.9
4	164	–	–	74.3	23.4	2.3	–	–	–	–	22.4	29.0	36.3	9.1	2.7	0.5	–	–	–	–
	168	–	–	72.6	25.0	2.5	–	–	–	–	18.9	28.5	36.0	11.6	4.2	0.7	0.1	–	–	–
	172	–	–	70.6	26.3	3.1	–	–	–	–	16.5	25.5	35.8	15.9	5.0	0.9	0.3	–	–	–
	239	–	–	6.0	46.2	47.8	–	–	–	–	–	–	0.2	3.8	16.4	25.6	29.7	14.3	6.4	3.6
	243	–	–	4.5	45.6	49.9	–	–	–	–	–	–	0.1	2.7	12.8	25.4	31.0	17.0	6.4	4.6
	247	–	–	4.0	45.5	50.6	–	–	–	–	–	–	–	2.0	10.6	25.1	31.5	19.2	6.5	5.0
5	174	–	–	–	84.4	11.2	4.4	–	–	–	15.1	23.9	34.4	18.7	6.1	1.3	0.4	–	–	–
	176	–	–	–	83.6	11.6	4.8	–	–	–	14.6	21.7	33.7	20.8	7.1	1.8	0.4	–	–	–
	179	–	–	–	81.8	12.6	5.6	–	–	–	14.2	18.4	31.0	24.9	8.7	2.3	0.5	–	–	–
	248	–	–	–	33.0	40.5	26.5	–	–	–	–	–	–	1.8	10.3	25.2	31.2	20.2	6.6	4.7
	249	–	–	–	32.4	40.6	27.0	–	–	–	–	–	–	1.6	10.1	25.2	30.9	20.9	6.6	4.6
	251	–	–	–	32.7	40.2	27.1	–	–	–	–	–	–	1.2	9.8	24.9	30.5	22.4	6.8	4.5
6	180	–	–	–	–	20.5	64.8	14.7	–	–	–	–	–	64.6	16.1	6.7	10.3	1.7	0.4	0.3
	181	–	–	–	–	20.7	64.6	14.7	–	–	–	–	–	63.8	16.3	6.6	10.6	2.1	0.3	0.3
	182	–	–	–	–	20.6	64.4	15.1	–	–	–	–	–	63.1	16.7	6.6	10.6	2.2	0.4	0.5
	254	–	–	–	–	4.3	28.5	67.2	–	–	–	–	–	0.3	0.5	3.8	10.9	17.5	16.0	51.0
	257	–	–	–	–	3.6	24.5	71.9	–	–	–	–	–	0.2	0.3	2.6	8.3	16.3	15.4	57.0
	260	–	–	–	–	2.8	20.7	76.5	–	–	–	–	–	0.1	0.2	1.5	5.9	15.3	13.9	63.1
7	183	–	–	–	–	–	79.1	16.2	4.6	–	–	–	–	61.9	17.0	6.8	10.8	2.4	0.5	0.6
	184	–	–	–	–	–	79.1	16.2	4.7	–	–	–	–	60.9	17.2	7.0	10.7	2.6	0.8	0.9
	185	–	–	–	–	–	78.8	16.4	4.9	–	–	–	–	59.9	18.0	6.9	11.0	2.6	0.8	0.9
	262	–	–	–	–	–	11.7	40.2	48.1	–	–	–	–	0.1	0.2	1.2	4.4	14.8	13.1	66.3
	264	–	–	–	–	–	9.7	41.2	49.0	–	–	–	–	–	0.2	0.9	3.2	14.3	12.4	69.0
	267	–	–	–	–	–	7.8	42.0	50.3	–	–	–	–	–	0.2	0.4	1.8	12.5	11.1	73.9
8	187	–	–	–	–	–	–	54.8	21.7	23.5	–	–	–	56.8	18.6	7.0	12.0	3.1	1.0	1.4
	189	–	–	–	–	–	–	54.5	21.9	23.6	–	–	–	53.6	20.1	6.8	12.6	3.6	1.3	2.0
	190	–	–	–	–	–	–	54.2	22.1	23.7	–	–	–	52.2	20.2	7.0	12.9	4.2	1.4	2.1
	268	–	–	–	–	–	–	13.9	12.3	73.7	–	–	–	–	0.1	0.4	1.6	11.9	10.8	75.3
	269	–	–	–	–	–	–	12.7	11.6	75.7	–	–	–	–	–	0.3	1.1	11.5	10.5	76.6
	270	–	–	–	–	–	–	12.4	11.5	76.1	–	–	–	–	–	0.3	1.1	10.9	10.0	77.7
	Min.	2.4	1.3	4.0	0.9	2.3	4.4	12.4	4.6	23.5	0.1	0.1	0.1	0.1	0.1	0.2	0.1	1.7	0.3	0.3
	Max.	19.1	92.1	74.3	84.4	50.6	79.1	76.5	50.3	76.1	55.0	29.0	37.2	64.6	37.8	25.6	31.5	22.4	16.0	77.7
	Mean	10.8	47.5	31.3	44.1	21.4	34.9	35.3	21.9	49.4	26.8	16.2	21.5	19.8	11.2	9.8	13.3	10.4	5.9	21.8
	SD	9.02	36.34	30.35	28.82	18.38	28.31	23.13	17.62	28.28	16.93	11.15	16.82	23.75	10.15	10.33	11.60	6.59	5.12	31.03

Notes: SG refers to simulee grade. Modal exposure rate for each RIT level and grade is shown in red.

Table C.5. Item Exposure Rates for Off-Grade Simulees—Reading

SG	True RIT	±1 Grade Item Pool									All-Grade Item Pool										
		G1	G2	G3	G4	G5	G6	G7	G8	G9	K	G1	G2	G3	G4	G5	G6	G7	G8	G9-10	G11-12
2	134	51.8	35.2	13.1	–	–	–	–	–	–	21.5	26.8	36.3	9.4	6.0	–	–	–	–	–	–
	138	51.7	35.3	13.0	–	–	–	–	–	–	21.5	26.7	36.2	9.6	6.0	–	–	–	–	–	–
	142	51.4	35.6	13.0	–	–	–	–	–	–	21.5	26.5	36.4	9.7	6.0	–	–	–	–	–	–
	218	–	13.1	86.9	–	–	–	–	–	–	–	–	0.5	2.7	9.0	16.7	34.5	20.5	12.6	2.5	1.0
	223	–	13.2	86.8	–	–	–	–	–	–	–	–	0.3	1.3	5.9	11.6	34.7	23.2	18.1	4.1	0.9
	227	–	13.0	87.0	–	–	–	–	–	–	–	–	0.1	0.6	4.4	7.5	32.5	26.2	22.5	5.4	0.9
3	145	–	73.6	16.8	9.6	–	–	–	–	–	21.2	26.4	36.1	10.0	6.3	–	–	–	–	–	–
	150	–	73.5	16.5	10.1	–	–	–	–	–	20.7	26.0	36.5	10.6	6.2	–	–	–	–	–	–
	154	–	72.6	16.7	10.7	–	–	–	–	–	20.1	25.2	36.3	11.6	6.8	0.1	–	–	–	–	–
	229	–	4.3	15.6	80.1	–	–	–	–	–	–	–	0.1	0.3	4.3	5.8	31.5	26.7	24.4	6.1	0.8
	232	–	4.3	15.5	80.2	–	–	–	–	–	–	–	–	0.2	3.8	3.8	29.5	28.2	26.8	7.2	0.6
	234	–	4.4	15.4	80.3	–	–	–	–	–	–	–	–	0.1	3.4	2.5	27.4	29.2	29.0	7.9	0.6
4	157	–	–	81.4	18.6	–	–	–	–	–	19.2	25.5	35.1	13.1	7.0	0.2	–	–	–	–	–
	161	–	–	81.3	18.6	–	–	–	–	–	16.7	24.7	33.5	16.3	8.3	0.6	–	–	–	–	–
	165	–	–	80.9	18.9	0.2	–	–	–	–	12.8	23.1	32.1	19.9	10.6	1.5	0.1	–	–	–	–
	236	–	–	3.2	29.3	67.4	–	–	–	–	–	–	–	0.1	3.2	1.8	26.1	29.3	30.1	9.0	0.5
	238	–	–	3.2	29.1	67.8	–	–	–	–	–	–	–	–	3.0	1.0	25.3	28.7	31.7	9.9	0.4
	241	–	–	3.2	29.2	67.6	–	–	–	–	–	–	–	–	2.7	0.5	24.2	28.2	33.3	10.9	0.2
5	167	–	–	–	99.6	0.3	0.1	–	–	–	10.3	22.2	30.8	22.3	12.2	2.2	–	–	–	–	–
	170	–	–	–	99.2	0.6	0.3	–	–	–	7.8	19.0	28.5	25.9	15.4	3.3	0.1	–	–	–	–
	172	–	–	–	98.6	1.0	0.4	–	–	–	5.8	17.0	27.9	27.1	17.3	4.7	0.2	–	–	–	–
	242	–	–	–	3.5	4.0	92.6	–	–	–	–	–	–	–	2.6	0.3	23.5	27.7	34.5	11.1	0.2
	244	–	–	–	3.5	4.0	92.5	–	–	–	–	–	–	–	2.5	0.2	23.3	27.8	34.5	11.6	0.1
	245	–	–	–	3.4	4.0	92.6	–	–	–	–	–	–	–	2.5	0.2	23.4	27.7	34.5	11.6	0.1
6	174	–	–	–	–	94.9	2.6	2.5	–	–	–	–	5.4	39.7	43.5	10.7	0.5	0.1	–	–	–
	176	–	–	–	–	94.7	2.7	2.6	–	–	–	–	5.6	39.2	42.8	11.6	0.7	0.2	–	–	–
	179	–	–	–	–	93.9	3.4	2.7	–	–	–	–	5.5	37.6	42.1	12.9	1.4	0.4	0.1	–	–
	246	–	–	–	–	0.2	33.5	66.3	–	–	–	–	–	–	0.1	0.2	2.0	5.2	13.4	40.5	38.6
	248	–	–	–	–	0.1	33.4	66.5	–	–	–	–	–	–	–	0.1	1.5	4.3	12.3	41.0	40.8
	249	–	–	–	–	0.1	33.3	66.6	–	–	–	–	–	–	–	0.1	1.3	3.7	11.9	41.3	41.7
7	180	–	–	–	–	–	86.5	12.3	1.3	–	–	–	5.6	37.1	41.4	13.7	1.5	0.4	0.1	–	–
	182	–	–	–	–	–	86.3	12.4	1.3	–	–	–	5.9	36.2	40.3	14.7	2.1	0.7	0.2	–	–
	183	–	–	–	–	–	86.3	12.3	1.4	–	–	–	5.6	36.0	39.4	15.3	2.7	0.8	0.2	–	–
	250	–	–	–	–	–	13.6	28.2	58.2	–	–	–	–	–	–	0.1	1.2	3.1	11.1	41.1	43.4
	252	–	–	–	–	–	13.5	28.4	58.1	–	–	–	–	–	–	0.1	0.9	2.1	10.7	41.3	44.9
	253	–	–	–	–	–	13.9	28.1	58.0	–	–	–	–	–	–	0.1	0.6	1.8	10.5	41.6	45.5
8	184	–	–	–	–	–	–	80.6	15.6	3.8	–	–	5.3	35.9	39.3	15.3	2.8	1.0	0.2	0.1	–
	186	–	–	–	–	–	–	80.5	15.7	3.8	–	–	5.3	34.1	38.2	16.6	4.0	1.4	0.3	0.1	0.1
	187	–	–	–	–	–	–	80.6	15.7	3.7	–	–	5.0	33.7	37.5	17.0	4.8	1.4	0.5	0.1	0.1
	254	–	–	–	–	–	–	23.1	43.4	33.5	–	–	–	–	–	–	0.5	1.5	10.2	42.1	45.7
	255	–	–	–	–	–	–	23.2	43.6	33.3	–	–	–	–	–	–	0.4	1.5	10.3	42.2	45.6
	256	–	–	–	–	–	–	23.1	43.4	33.5	–	–	–	–	–	–	0.3	1.3	10.4	42.7	45.3
	Min.	51.4	4.3	3.2	3.4	0.1	0.1	2.5	1.3	3.7	5.8	17.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Max.	51.8	73.6	87.0	99.6	94.9	92.6	80.6	58.2	33.5	21.5	26.8	36.5	39.7	43.5	17.0	34.7	29.3	34.5	42.7	45.7
	Mean	51.6	31.5	36.1	40.1	31.3	38.2	35.6	29.6	18.6	16.6	24.1	18.2	18.6	15.3	5.7	11.1	11.8	15.5	19.6	17.3
	SD	0.2	27.8	35.2	37.4	40.7	38.9	29.1	23.3	16.2	5.8	3.2	15.5	14.7	15.8	6.3	13.3	12.7	12.4	17.7	21.5

Notes: SG refers to simulee grade. Modal exposure rate for each RIT level and grade is shown in red.

Table C.6. Item Exposure Rates for Off-Grade Simulees—Language Usage

SG	True RIT	±1 Grade Item Pool									All-Grade Item Pool										
		G1	G2	G3	G4	G5	G6	G7	G8	G9	K	G1	G2	G3	G4	G5	G6	G7	G8	G9-10	G11-12
2	134	44.7	25.1	30.2	–	–	–	–	–	–	11.9	34.1	16.8	29.7	7.5	–	–	–	–	–	–
	138	44.5	25.1	30.3	–	–	–	–	–	–	11.9	33.9	16.8	29.8	7.6	–	–	–	–	–	–
	142	44.4	25.2	30.4	–	–	–	–	–	–	12.0	33.8	16.7	29.7	7.8	–	–	–	–	–	–
	216	1.2	6.9	91.9	–	–	–	–	–	–	–	0.4	1.4	9.0	18.0	14.2	14.4	16.5	10.8	10.5	4.7
	220	0.6	5.3	94.1	–	–	–	–	–	–	–	0.1	0.7	6.5	12.6	11.3	14.8	19.2	13.2	15.1	6.7
	224	0.3	4.6	95.2	–	–	–	–	–	–	–	–	0.3	4.8	8.4	9.0	13.7	20.5	15.2	19.5	8.7
3	155	–	50.0	31.8	18.2	–	–	–	–	–	12.5	32.0	17.6	29.1	8.6	0.1	–	–	–	–	–
	157	–	49.6	32.8	17.6	–	–	–	–	–	12.4	30.8	18.3	29.3	9.0	0.1	–	0.1	–	–	–
	159	–	48.7	34.4	17.0	–	–	–	–	–	12.1	30.7	18.7	29.6	8.7	0.1	–	–	–	–	–
	226	–	0.7	30.4	68.8	–	–	–	–	–	–	–	0.2	3.9	7.2	7.6	13.2	20.8	15.7	21.6	9.9
	228	–	0.4	31.6	68.0	–	–	–	–	–	–	–	0.1	3.7	5.9	7.4	12.4	21.3	15.9	22.7	10.6
	231	–	0.2	32.6	67.1	–	–	–	–	–	–	–	–	3.4	4.9	6.9	11.0	21.4	16.2	24.4	11.9
4	160	–	–	72.8	25.5	1.7	–	–	–	–	11.8	30.8	19.1	29.2	8.8	0.2	–	0.1	–	–	–
	165	–	–	75.5	22.9	1.6	–	–	–	–	9.7	28.9	20.6	30.4	9.5	0.4	0.1	0.2	–	–	–
	169	–	–	77.8	19.9	2.3	–	–	–	–	8.2	27.6	20.8	31.1	10.9	0.8	0.2	0.4	–	–	–
	232	–	–	20.1	28.5	51.4	–	–	–	–	–	–	–	3.3	4.8	6.6	10.2	21.5	16.5	24.6	12.4
	234	–	–	20.4	27.7	52.0	–	–	–	–	–	–	–	3.2	4.3	6.7	9.8	20.1	17.5	25.7	12.8
	236	–	–	20.0	27.8	52.2	–	–	–	–	–	–	–	2.8	3.7	6.3	9.3	19.4	17.6	26.5	14.3
5	170	–	–	–	91.4	5.6	3.0	–	–	–	7.8	27.6	20.5	31.2	11.2	1.0	0.3	0.5	–	–	–
	173	–	–	–	90.3	6.7	3.0	–	–	–	6.4	26.4	20.3	31.4	13.3	1.5	0.3	0.5	–	–	–
	176	–	–	–	87.6	9.1	3.3	–	–	–	5.2	26.0	19.7	31.0	14.4	2.3	0.7	0.6	–	–	–
	237	–	–	–	15.0	23.9	61.0	–	–	–	–	–	–	2.8	3.5	6.2	9.1	17.9	18.3	27.5	14.8
	239	–	–	–	14.3	23.7	62.0	–	–	–	–	–	–	2.5	3.3	6.0	8.7	16.4	20.1	27.9	15.1
	241	–	–	–	14.3	23.3	62.4	–	–	–	–	–	–	2.1	2.8	5.7	8.4	15.0	21.0	29.3	15.8
6	177	–	–	–	–	78.1	11.3	10.6	–	–	5.0	25.0	19.5	31.4	14.9	3.0	0.7	0.5	–	–	–
	179	–	–	–	–	78.8	11.1	10.2	–	–	3.9	23.4	19.4	31.2	16.4	4.1	1.0	0.6	–	–	–
	180	–	–	–	–	79.0	11.1	9.9	–	–	3.7	22.8	19.2	31.2	16.5	4.6	1.2	0.7	0.1	–	–
	242	–	–	–	–	20.6	36.1	43.3	–	–	–	–	–	1.9	2.7	5.5	8.4	14.1	21.4	29.5	16.5
	243	–	–	–	–	20.6	36.2	43.2	–	–	–	–	–	1.8	2.6	5.2	8.0	13.4	21.4	30.5	17.1
	244	–	–	–	–	20.5	36.2	43.3	–	–	–	–	–	1.6	2.3	5.4	8.2	12.5	21.9	30.7	17.4
7	181	–	–	–	–	–	74.4	21.4	4.2	–	3.4	21.7	19.4	31.6	16.5	5.4	1.2	0.7	0.1	–	–
	183	–	–	–	–	–	74.6	21.0	4.4	–	2.9	20.2	19.2	30.9	17.6	6.7	1.6	0.7	0.1	–	–
	184	–	–	–	–	–	74.6	20.9	4.5	–	2.3	19.5	18.8	30.3	18.6	7.6	1.9	0.9	0.1	–	–
	245	–	–	–	–	–	26.2	27.8	46.1	–	–	–	–	1.4	2.3	5.1	8.3	12.3	21.9	31.2	17.5
	247	–	–	–	–	–	26.6	27.3	46.2	–	–	–	–	1.0	2.3	5.1	8.1	11.5	21.6	32.1	18.3
	248	–	–	–	–	–	26.5	26.8	46.7	–	–	–	–	1.1	2.1	4.9	7.8	11.1	21.5	33.2	18.4
8	185	–	–	–	–	–	–	80.4	13.8	5.8	2.3	17.9	17.9	30.4	19.9	8.2	2.2	1.0	0.2	–	–
	186	–	–	–	–	–	–	80.6	13.7	5.7	2.3	16.9	17.8	30.0	20.4	9.1	2.3	1.0	0.2	–	0.1
	188	–	–	–	–	–	–	80.5	13.7	5.9	1.7	14.6	16.1	30.2	21.6	10.7	3.0	1.4	0.5	0.1	0.1
	249	–	–	–	–	–	–	30.2	41.8	27.9	–	–	–	0.9	2.1	5.0	7.8	10.9	21.4	33.2	18.7
	250	–	–	–	–	–	–	30.2	41.9	27.9	–	–	–	0.8	2.1	5.1	7.7	10.6	21.4	33.6	18.7
	251	–	–	–	–	–	–	30.2	41.8	27.9	–	–	–	0.8	2.1	5.1	7.7	10.5	21.3	33.7	18.9
	Min.	0.3	0.2	20.0	14.3	1.6	3.0	9.9	4.2	5.7	1.7	0.1	0.1	0.8	2.1	0.1	0.1	0.1	0.1	0.1	0.1
	Max.	44.7	50.0	95.2	91.4	79.0	74.6	80.6	46.7	27.9	12.5	34.1	20.8	31.6	21.6	14.2	14.8	21.5	21.9	33.7	18.9
	Mean	22.6	20.2	47.3	40.1	30.6	35.5	35.4	26.6	16.9	7.1	23.7	15.2	16.6	9.0	5.3	6.4	9.4	14.0	25.6	13.0
	SD	24.0	20.1	28.0	29.3	27.5	26.4	23.1	18.7	12.1	4.1	9.3	7.4	14.0	6.1	3.3	4.7	8.3	8.6	8.3	5.7

Notes: SG refers to simulee grade. Modal exposure rate for each RIT level and grade is shown in red.

Appendix D: Pool Utilization

Table D.1. Pool Utilization for On-Grade Simulees—Mathematics

Grade	True RIT	On-Grade Item Pool			±1Grade Item Pool			All-Grade Item Pool		
		Total #Items	Items Used		Total #Items	Items Used		Total #Items	Items Used	
			N	%		N	%		N	%
	147	445	98	22.0	1,621	201	12.4	5,536	235	4.2
	155	445	164	36.9	1,621	395	24.4	5,536	464	8.4
	164	445	283	63.6	1,621	726	44.8	5,536	966	17.4
2	180	445	442	99.3	1,621	1,385	85.4	5,536	2,218	40.1
	197	445	388	87.2	1,621	1,292	79.7	5,536	3,539	63.9
	206	445	291	65.4	1,621	917	56.6	5,536	3,720	67.2
	214	445	173	38.9	1,621	611	37.7	5,536	3,388	61.2
	160	922	248	26.9	1,771	391	22.1	5,536	719	13.0
	168	922	405	43.9	1,771	652	36.8	5,536	1,196	21.6
	176	922	637	69.1	1,771	960	54.2	5,536	1,828	33.0
3	192	922	899	97.5	1,771	1,613	91.1	5,536	3,291	59.4
	208	922	674	73.1	1,771	1,294	73.1	5,536	3,706	66.9
	216	922	463	50.2	1,771	926	52.3	5,536	3,233	58.4
	224	922	265	28.7	1,771	526	29.7	5,536	2,370	42.8
	170	1,004	298	29.7	1,910	578	30.3	5,536	1,344	24.3
	177	1,004	467	46.5	1,910	907	47.5	5,536	1,892	34.2
	185	1,004	738	73.5	1,910	1,336	69.9	5,536	2,717	49.1
4	201	1,004	979	97.5	1,910	1,705	89.3	5,536	3,697	66.8
	216	1,004	736	73.3	1,910	1,150	60.2	5,536	3,246	58.6
	224	1,004	432	43.0	1,910	686	35.9	5,536	2,383	43.0
	231	1,004	238	23.7	1,910	415	21.7	5,536	1,657	29.9
	177	681	258	37.9	1,730	575	33.2	5,536	1,904	34.4
	184	681	420	61.7	1,730	900	52.0	5,536	2,584	46.7
	192	681	594	87.2	1,730	1,322	76.4	5,536	3,266	59.0
5	207	681	680	99.9	1,730	1,598	92.4	5,536	3,729	67.4
	222	681	478	70.2	1,730	980	56.6	5,536	2,609	47.1
	229	681	297	43.6	1,730	642	37.1	5,536	1,855	33.5
	236	681	189	27.8	1,730	384	22.2	5,536	1,196	21.6
	181	512	130	25.4	1,284	423	32.9	5,536	2,309	41.7
	189	512	263	51.4	1,284	675	52.6	5,536	2,988	54.0
	196	512	406	79.3	1,284	958	74.6	5,536	3,558	64.3
6	211	512	509	99.4	1,284	1,203	93.7	5,536	3,636	65.7
	226	512	448	87.5	1,284	846	65.9	5,536	2,173	39.3
	233	512	307	60.0	1,284	571	44.5	5,536	1,486	26.8
	241	512	179	35.0	1,284	338	26.3	5,536	858	15.5
	185	509	133	26.1	1,005	246	24.5	5,536	2,692	48.6
	193	509	267	52.5	1,005	473	47.1	5,536	3,384	61.1
	200	509	374	73.5	1,005	718	71.4	5,536	3,676	66.4
7	215	509	504	99.0	1,005	978	97.3	5,536	3,362	60.7
	230	509	447	87.8	1,005	785	78.1	5,536	1,727	31.2
	237	509	332	65.2	1,005	533	53.0	5,536	1,125	20.3
	244	509	205	40.3	1,005	335	33.3	5,536	733	13.2
	189	366	120	32.8	861	227	26.4	5,536	3,035	54.8
	196	366	209	57.1	861	435	50.5	5,536	3,527	63.7
	204	366	306	83.6	861	660	76.7	5,536	3,702	66.9
8	218	366	363	99.2	861	852	99.0	5,536	3,011	54.4
	233	366	342	93.4	861	692	80.4	5,536	1,479	26.7
	241	366	248	67.8	861	460	53.4	5,536	861	15.6
	248	366	159	43.4	861	296	34.4	5,536	509	9.2
	Min.	–	–	22.0	–	–	12.4	–	–	4.2
	Max.	–	–	99.9	–	–	99.0	–	–	67.4
	Mean	–	–	60.8	–	–	53.9	–	–	42.3
	SD	–	–	25.2	–	–	23.9	–	–	19.6

Table D.2. Pool Utilization for On-Grade Simulees—Reading

Grade	True RIT	On-Grade Item Pool			±1Grade Item Pool			All-Grade Item Pool		
		Total #Items	Items Used		Total #Items	Items Used		Total #Items	Items Used	
			N	%		N	%		N	%
2	145	584	126	21.6	1,324	157	11.9	5,727	218	3.8
	154	584	274	46.9	1,324	329	24.8	5,727	536	9.4
	163	584	440	75.3	1,324	601	45.4	5,727	1,073	18.7
	180	584	578	99.0	1,324	1,165	88.0	5,727	2,471	43.1
	198	584	351	60.1	1,324	932	70.4	5,727	3,740	65.3
	207	584	193	33.0	1,324	649	49.0	5,727	3,694	64.5
	216	584	85	14.6	1,324	345	26.1	5,727	2,786	48.6
3	157	1,072	231	21.5	2,012	398	19.8	5,727	722	12.6
	165	1,072	446	41.6	2,012	690	34.3	5,727	1,231	21.5
	174	1,072	714	66.6	2,012	1,067	53.0	5,727	1,867	32.6
	192	1,072	1,035	96.5	2,012	1,754	87.2	5,727	3,395	59.3
	209	1,072	567	52.9	2,012	1,124	55.9	5,727	3,612	63.1
	218	1,072	298	27.8	2,012	645	32.1	5,727	2,556	44.6
	227	1,072	125	11.7	2,012	278	13.8	5,727	1,468	25.6
4	167	1,216	339	27.9	2,271	602	26.5	5,727	1,348	23.5
	175	1,216	523	43.0	2,271	952	41.9	5,727	1,973	34.5
	184	1,216	883	72.6	2,271	1,505	66.3	5,727	2,874	50.2
	201	1,216	1,117	91.9	2,271	1,902	83.8	5,727	3,856	67.3
	218	1,216	563	46.3	2,271	995	43.8	5,727	2,476	43.2
	226	1,216	284	23.4	2,271	504	22.2	5,727	1,579	27.6
	234	1,216	124	10.2	2,271	224	9.9	5,727	784	13.7
5	174	969	249	25.7	2,441	551	22.6	5,727	1,831	32.0
	183	969	471	48.6	2,441	991	40.6	5,727	2,719	47.5
	181	969	767	79.2	2,441	1,552	63.6	5,727	3,317	57.9
	208	969	925	95.5	2,441	2,144	87.8	5,727	3,658	63.9
	224	969	494	51.0	2,441	1,143	46.8	5,727	1,810	31.6
	232	969	266	27.5	2,441	565	23.1	5,727	963	16.8
	241	969	88	9.1	2,441	247	10.1	5,727	423	7.4
6	180	1,036	199	19.2	2,106	457	21.7	6,472	1,495	23.1
	188	1,036	390	37.6	2,106	840	39.9	6,472	2,432	37.6
	196	1,036	688	66.4	2,106	1,381	65.6	6,472	3,402	52.6
	212	1,036	1,029	99.3	2,106	1,958	93.0	6,472	4,428	68.4
	229	1,036	645	62.3	2,106	971	46.1	6,472	2,703	41.8
	237	1,036	349	33.7	2,106	520	24.7	6,472	1692	26.1
	245	1,036	167	16.1	2,106	249	11.8	6,472	931	14.4
7	184	697	166	23.8	1,893	339	17.9	6,472	1,906	29.4
	192	697	307	44.0	1,893	623	32.9	6,472	2,907	44.9
	200	697	514	73.7	1,893	1,131	59.7	6,472	3,853	59.5
	216	697	695	99.7	1,893	1,807	95.5	6,472	4,202	64.9
	233	697	452	64.8	1,893	991	52.4	6,472	2,135	33.0
	241	697	251	36.0	1,893	537	28.4	6,472	1,217	18.8
	249	697	131	18.8	1,893	281	14.8	6,472	657	10.2
8	188	710	132	18.6	1,382	250	18.1	6,472	2,460	38.0
	196	710	266	37.5	1,382	514	37.2	6,472	3,404	52.6
	204	710	480	67.6	1,382	911	65.9	6,472	4,149	64.1
	220	710	707	99.6	1,382	1,356	98.1	6,472	3,866	59.7
	237	710	507	71.4	1,382	747	54.1	6,472	1,704	26.3
	245	710	286	40.3	1,382	429	31.0	6,472	893	13.8
	253	710	144	20.3	1,382	193	14.0	6,472	425	6.6
	Min.	–	–	9.1	–	–	9.9	–	–	3.8
	Max.	–	–	99.7	–	–	98.1	–	–	68.4
	Mean	–	–	48.4	–	–	43.3	–	–	37.1
	SD	–	–	27.9	–	–	25.6	–	–	19.5

Table D.3. Pool Utilization for On-Grade Simulees—Language Usage

Grade	True RIT	On-Grade Item Pool			±1Grade Item Pool			All-Grade Item Pool		
		Total #Items	Items Used		Total #Items	Items Used		Total #Items	Items Used	
			N	%		N	%		N	%
	147	445	98	22.0	1,621	201	12.4	5,536	235	4.2
	155	445	164	36.9	1,621	395	24.4	5,536	464	8.4
	164	445	283	63.6	1,621	726	44.8	5,536	966	17.4
2	180	445	442	99.3	1,621	1,385	85.4	5,536	2,218	40.1
	197	445	388	87.2	1,621	1,292	79.7	5,536	3,539	63.9
	206	445	291	65.4	1,621	917	56.6	5,536	3,720	67.2
	214	445	173	38.9	1,621	611	37.7	5,536	3,388	61.2
	160	922	248	26.9	1,771	391	22.1	5,536	719	13.0
	168	922	405	43.9	1,771	652	36.8	5,536	1,196	21.6
	176	922	637	69.1	1,771	960	54.2	5,536	1,828	33.0
3	192	922	899	97.5	1,771	1,613	91.1	5,536	3,291	59.4
	208	922	674	73.1	1,771	1,294	73.1	5,536	3,706	66.9
	216	922	463	50.2	1,771	926	52.3	5,536	3,233	58.4
	224	922	265	28.7	1,771	526	29.7	5,536	2,370	42.8
	170	1,004	298	29.7	1,910	578	30.3	5,536	1,344	24.3
	177	1,004	467	46.5	1,910	907	47.5	5,536	1,892	34.2
	185	1,004	738	73.5	1,910	1,336	69.9	5,536	2,717	49.1
4	201	1,004	979	97.5	1,910	1,705	89.3	5,536	3,697	66.8
	216	1,004	736	73.3	1,910	1,150	60.2	5,536	3,246	58.6
	224	1,004	432	43.0	1,910	686	35.9	5,536	2,383	43.0
	231	1,004	238	23.7	1,910	415	21.7	5,536	1,657	29.9
	177	681	258	37.9	1,730	575	33.2	5,536	1,904	34.4
	184	681	420	61.7	1,730	900	52.0	5,536	2,584	46.7
	192	681	594	87.2	1,730	1,322	76.4	5,536	3,266	59.0
5	207	681	680	99.9	1,730	1,598	92.4	5,536	3,729	67.4
	222	681	478	70.2	1,730	980	56.6	5,536	2,609	47.1
	229	681	297	43.6	1,730	642	37.1	5,536	1,855	33.5
	236	681	189	27.8	1,730	384	22.2	5,536	1,196	21.6
	181	512	130	25.4	1,284	423	32.9	5,536	2,309	41.7
	189	512	263	51.4	1,284	675	52.6	5,536	2,988	54.0
	196	512	406	79.3	1,284	958	74.6	5,536	3,558	64.3
6	211	512	509	99.4	1,284	1,203	93.7	5,536	3,636	65.7
	226	512	448	87.5	1,284	846	65.9	5,536	2,173	39.3
	233	512	307	60.0	1,284	571	44.5	5,536	1,486	26.8
	241	512	179	35.0	1,284	338	26.3	5,536	858	15.5
	185	509	133	26.1	1,005	246	24.5	5,536	2,692	48.6
	193	509	267	52.5	1,005	473	47.1	5,536	3,384	61.1
	200	509	374	73.5	1,005	718	71.4	5,536	3,676	66.4
7	215	509	504	99.0	1,005	978	97.3	5,536	3,362	60.7
	230	509	447	87.8	1,005	785	78.1	5,536	1,727	31.2
	237	509	332	65.2	1,005	533	53.0	5,536	1,125	20.3
	244	509	205	40.3	1,005	335	33.3	5,536	733	13.2
	189	366	120	32.8	861	227	26.4	5,536	3,035	54.8
	196	366	209	57.1	861	435	50.5	5,536	3,527	63.7
	204	366	306	83.6	861	660	76.7	5,536	3,702	66.9
8	218	366	363	99.2	861	852	99.0	5,536	3,011	54.4
	233	366	342	93.4	861	692	80.4	5,536	1,479	26.7
	241	366	248	67.8	861	460	53.4	5,536	861	15.6
	248	366	159	43.4	861	296	34.4	5,536	509	9.2
	Min.	–	–	22.0	–	–	12.4	–	–	4.2
	Max.	–	–	99.9	–	–	99.0	–	–	67.4
	Mean	–	–	60.8	–	–	53.9	–	–	42.3
	SD	–	–	25.2	–	–	23.9	–	–	19.6

Table D.4. Pool Utilization for Off-Grade Simulees—Mathematics

Grade	True RIT	On-Grade Item Pool			±1Grade Item Pool			All-Grade Item Pool		
		Total #Items	Items Used		Total #Items	Items Used		Total #Items	Items Used	
			N	%		N	%		N	%
2	133	689	88	12.8	1,926	124	6.4	4,793	180	3.8
	138	689	126	18.3	1,926	167	8.7	4,793	275	5.7
	142	689	179	26.0	1,926	232	12.0	4,793	384	8.0
	216	689	171	24.8	1,926	719	37.3	4,793	2,581	53.8
	220	689	136	19.7	1,926	579	30.1	4,793	2,445	51.0
	224	689	109	15.8	1,926	447	23.2	4,793	2,319	48.4
3	151	928	96	10.3	2,543	355	14.0	4,793	663	13.8
	159	928	183	19.7	2,543	573	22.5	4,793	997	20.8
	162	928	232	25.0	2,543	685	26.9	4,793	1,143	23.8
	228	928	321	34.6	2,543	788	31.0	4,793	2,063	43.0
	232	928	257	27.7	2,543	651	25.6	4,793	1,868	39.0
	236	928	215	23.2	2,543	497	19.5	4,793	1,525	31.8
4	164	1,020	120	11.8	2,598	337	13.0	4,793	1,222	25.5
	168	1,020	156	15.3	2,598	437	16.8	4,793	1,410	29.4
	172	1,020	195	19.1	2,598	574	22.1	4,793	1,614	33.7
	239	1,020	323	31.7	2,598	826	31.8	4,793	1,343	28.0
	243	1,020	252	24.7	2,598	650	25.0	4,793	1,089	22.7
	247	1,020	180	17.6	2,598	497	19.1	4,793	862	18.0
5	174	822	116	14.1	2,815	341	12.1	4,793	1,668	34.8
	176	822	118	14.4	2,815	374	13.3	4,793	1,757	36.7
	179	822	142	17.3	2,815	450	16.0	4,793	1,895	39.5
	248	822	380	46.2	2,815	852	30.3	4,793	805	16.8
	249	822	361	43.9	2,815	791	28.1	4,793	730	15.2
	251	822	330	40.1	2,815	718	25.5	4,793	623	13.0
6	180	1,166	167	14.3	2,742	300	10.9	6,657	829	12.5
	181	1,166	177	15.2	2,742	293	10.7	6,657	893	13.4
	182	1,166	209	17.9	2,742	314	11.5	6,657	941	14.1
	254	1,166	434	37.2	2,742	887	32.3	6,657	2,656	39.9
	257	1,166	379	32.5	2,742	746	27.2	6,657	2,362	35.5
	260	1,166	300	25.7	2,742	607	22.1	6,657	2,106	31.6
7	183	945	120	12.7	2,716	250	9.2	6,657	1,019	15.3
	184	945	123	13.0	2,716	275	10.1	6,657	1,112	16.7
	185	945	125	13.2	2,716	296	10.9	6,657	1,126	16.9
	262	945	322	34.1	2,716	821	30.2	6,657	1,949	29.3
	264	945	310	32.8	2,716	696	25.6	6,657	1,767	26.5
	267	945	255	27.0	2,716	599	22.1	6,657	1,538	23.1
8	187	718	64	8.9	2,824	173	6.1	6,657	1,199	18.0
	189	718	73	10.2	2,824	178	6.3	6,657	1,348	20.2
	190	718	71	9.9	2,824	210	7.4	6,657	1,442	21.7
	268	718	331	46.1	2,824	1,316	46.6	6,657	1,448	21.8
	269	718	313	43.6	2,824	1,208	42.8	6,657	1,357	20.4
	270	718	300	41.8	2,824	1,183	41.9	6,657	1,290	19.4
	Min.	–	–	8.9	–	–	6.1	–	–	3.8
	Max.	–	–	46.2	–	–	46.6	–	–	53.8
	Mean	–	–	23.6	–	–	21.1	–	–	25.1
	SD	–	–	11.2	–	–	10.7	–	–	12.1

Table D.5. Pool Utilization for Off-Grade Simulees—Reading

Grade	True RIT	On-Grade Item Pool			±1Grade Item Pool			All-Grade Item Pool		
		Total #Items	Items Used		Total #Items	Items Used		Total #Items	Items Used	
			N	%		N	%		N	%
2	134	584	63	10.8	1,324	71	5.4	5,727	76	1.3
	138	584	75	12.8	1,324	80	6.0	5,727	112	2.0
	142	584	88	15.1	1,324	118	8.9	5,727	160	2.8
	218	584	78	13.4	1,324	300	22.7	5,727	2,515	43.9
	223	584	58	9.9	1,324	194	14.7	5,727	1,929	33.7
	227	584	53	9.1	1,324	128	9.7	5,727	1,435	25.1
3	145	1,072	92	8.6	2,012	123	6.1	5,727	218	3.8
	150	1,072	124	11.6	2,012	217	10.8	5,727	351	6.1
	154	1,072	189	17.6	2,012	322	16.0	5,727	543	9.5
	229	1,072	100	9.3	2,012	218	10.8	5,727	1,241	21.7
	232	1,072	83	7.7	2,012	165	8.2	5,727	969	16.9
	234	1,072	65	6.1	2,012	135	6.7	5,727	768	13.4
4	157	1,216	127	10.4	2,271	285	12.5	5,727	722	12.6
	161	1,216	196	16.1	2,271	402	17.7	5,727	962	16.8
	165	1,216	270	22.2	2,271	561	24.7	5,727	1,219	21.3
	236	1,216	111	9.1	2,271	184	8.1	5,727	677	11.8
	238	1,216	84	6.9	2,271	154	6.8	5,727	539	9.4
	241	1,216	66	5.4	2,271	104	4.6	5,727	366	6.4
5	167	969	139	14.3	2,441	325	13.3	5,727	1,348	23.5
	170	969	179	18.5	2,441	417	17.1	5,727	1,585	27.7
	172	969	202	20.8	2,441	464	19.0	5,727	1,708	29.8
	242	969	88	9.1	2,441	233	9.5	5,727	335	5.8
	244	969	67	6.9	2,441	188	7.7	5,727	276	4.8
	245	969	61	6.3	2,441	164	6.7	5,727	272	4.7
6	174	1,036	112	10.8	2,106	289	13.7	6,472	941	14.5
	176	1,036	137	13.2	2,106	319	15.1	6,472	1,099	17.0
	179	1,036	164	15.8	2,106	433	20.6	6,472	1,402	21.7
	246	1,036	130	12.5	2,106	228	10.8	6,472	870	13.4
	248	1,036	110	10.6	2,106	197	9.4	6,472	700	10.8
	249	1,036	102	9.8	2,106	168	8.0	6,472	688	10.6
7	180	697	115	16.5	1,893	223	11.8	6,472	1,495	23.1
	182	697	132	18.9	1,893	288	15.2	6,472	1,687	26.1
	183	697	135	19.4	1,893	314	16.6	6,472	1,844	28.5
	250	697	118	16.9	1,893	228	12.0	6,472	559	8.6
	252	697	95	13.6	1,893	194	10.2	6,472	487	7.5
	253	697	95	13.6	1,893	165	8.7	6,472	441	6.8
8	184	710	102	14.4	1,382	181	13.1	6,472	1,906	29.4
	186	710	115	16.2	1,382	207	15.0	6,472	2,143	33.1
	187	710	124	17.5	1,382	247	17.9	6,472	2,257	34.9
	254	710	130	18.3	1,382	196	14.2	6,472	392	6.1
	255	710	122	17.2	1,382	166	12.0	6,472	369	5.7
	256	710	118	16.6	1,382	151	10.9	6,472	297	4.6
	Min.	–	–	5.4	–	–	4.6	–	–	1.3
	Max.	–	–	22.2	–	–	24.7	–	–	43.9
	Mean	–	–	13.1	–	–	12.1	–	–	15.7
	SD	–	–	4.4	–	–	4.8	–	–	10.8

Table D.6. Pool Utilization for Off-Grade Simulees—Language Usage

Grade	True RIT	On-Grade Item Pool			±1Grade Item Pool			All-Grade Item Pool		
		Total #Items	Items Used		Total #Items	Items Used		Total #Items	Items Used	
			N	%		N	%		N	%
2	134	445	58	13.0	1,621	64	3.9	5,536	75	1.4
	138	445	60	13.5	1,621	93	5.7	5,536	100	1.8
	142	445	71	16.0	1,621	129	8.0	5,536	151	2.7
	216	445	153	34.4	1,621	531	32.8	5,536	3,220	58.2
	220	445	125	28.1	1,621	398	24.6	5,536	2,794	50.5
	224	445	79	17.8	1,621	271	16.7	5,536	2,383	43.0
3	155	922	184	20.0	1,771	262	14.8	5,536	495	8.9
	157	922	203	22.0	1,771	312	17.6	5,536	616	11.1
	159	922	242	26.2	1,771	387	21.9	5,536	666	12.0
	226	922	214	23.2	1,771	445	25.1	5,536	2,184	39.5
	228	922	194	21.0	1,771	370	20.9	5,536	1,962	35.4
	231	922	128	13.9	1,771	317	17.9	5,536	1,696	30.6
4	160	1,004	134	13.3	1,910	303	15.9	5,536	719	13.0
	165	1,004	201	20.0	1,910	415	21.7	5,536	1,003	18.1
	169	1,004	268	26.7	1,910	550	28.8	5,536	1,278	23.1
	232	1,004	223	22.2	1,910	369	19.3	5,536	1,612	29.1
	234	1,004	183	18.2	1,910	313	16.4	5,536	1,431	25.8
	236	1,004	141	14.0	1,910	261	13.7	5,536	1,217	22.0
5	170	681	122	17.9	1,730	347	20.1	5,536	1,344	24.3
	173	681	176	25.8	1,730	423	24.5	5,536	1,564	28.3
	176	681	250	36.7	1,730	510	29.5	5,536	1,828	33.0
	237	681	139	20.4	1,730	341	19.7	5,536	1,114	20.1
	239	681	127	18.6	1,730	305	17.6	5,536	994	18.0
	241	681	90	13.2	1,730	223	12.9	5,536	861	15.6
6	177	512	99	19.3	1,284	294	22.9	5,536	1,904	34.4
	179	512	122	23.8	1,284	386	30.1	5,536	2,094	37.8
	180	512	124	24.2	1,284	391	30.5	5,536	2,219	40.1
	242	512	169	33.0	1,284	319	24.8	5,536	784	14.2
	243	512	140	27.3	1,284	295	23.0	5,536	744	13.4
	244	512	117	22.9	1,284	274	21.3	5,536	693	12.5
7	181	509	102	20.0	1,005	179	17.8	5,536	2,309	41.7
	183	509	125	24.6	1,005	209	20.8	5,536	2,491	45.0
	184	509	122	24.0	1,005	242	24.1	5,536	2,573	46.5
	245	509	198	38.9	1,005	315	31.3	5,536	650	11.7
	247	509	170	33.4	1,005	302	30.0	5,536	558	10.1
	248	509	158	31.0	1,005	251	25.0	5,536	513	9.3
8	185	366	82	22.4	861	172	20.0	5,536	2,692	48.6
	186	366	89	24.3	861	195	22.6	5,536	2,732	49.3
	188	366	118	32.2	861	217	25.2	5,536	3,017	54.5
	249	366	141	38.5	861	258	30.0	5,536	457	8.3
	250	366	132	36.1	861	255	29.6	5,536	424	7.7
	251	366	119	32.5	861	235	27.3	5,536	421	7.6
	Min.	–	–	13.0	–	–	3.9	–	–	1.4
	Max.	–	–	38.9	–	–	32.8	–	–	58.2
	Mean	–	–	23.9	–	–	21.6	–	–	25.2
	SD	–	–	7.4	–	–	6.8	–	–	16.1

Appendix E: Content Balancing

Table E.1. Content Balancing for On-Grade Simulees—Mathematics

Grade	True RIT	On-Grade Item Pool			±1 Grade Item Pool			All-Grade Item Pool		
		Balanced	Slightly Unbalanced	Extremely Unbalanced	Balanced	Slightly Unbalanced	Extremely Unbalanced	Balanced	Slightly Unbalanced	Extremely Unbalanced
2	151	100.0	–	–	100.0	–	–	100.0	–	–
	159	100.0	–	–	100.0	–	–	100.0	–	–
	167	99.8	0.2	–	100.0	–	–	100.0	–	–
	183	100.0	–	–	100.0	–	–	100.0	–	–
	199	99.8	0.2	–	100.0	–	–	100.0	–	–
	207	100.0	–	–	99.8	0.2	–	100.0	–	–
	215	100.0	–	–	99.4	0.6	–	100.0	–	–
3	164	99.8	0.2	–	100.0	–	–	100.0	–	–
	172	100.0	–	–	100.0	–	–	100.0	–	–
	179	100.0	–	–	100.0	–	–	99.9	0.1	–
	194	100.0	–	–	100.0	–	–	100.0	–	–
	209	100.0	–	–	100.0	–	–	100.0	–	–
	216	99.4	0.6	–	100.0	–	–	99.9	0.1	–
	224	99.1	0.9	–	100.0	–	–	99.7	0.2	0.1
4	174	99.8	0.2	–	100.0	–	–	99.9	0.1	–
	181	98.7	1.3	–	100.0	–	–	100.0	–	–
	189	98.9	1.1	–	100.0	–	–	100.0	–	–
	205	99.9	0.1	–	99.9	0.1	–	100.0	–	–
	220	100.0	–	–	99.2	0.8	–	99.6	0.4	–
	228	100.0	–	–	97.1	2.9	–	99.7	0.3	–
	236	99.9	0.1	–	97.6	2.4	–	99.9	0.1	–
5	180	97.6	2.5	–	80.8	1.1	18.2	100.0	–	–
	188	94.4	5.6	–	80.4	2.5	17.1	100.0	–	–
	197	93.8	6.2	–	80.2	4.3	15.5	100.0	–	–
	214	88.0	11.4	0.6	82.5	9.3	8.2	100.0	–	–
	230	80.1	18.9	1.0	93.0	6.0	1.0	99.7	0.3	–
	239	87.1	12.4	0.5	92.9	7.1	–	100.0	–	–
	247	94.6	5.3	0.1	86.5	13.5	–	100.0	–	–
6	183	95.1	4.9	–	96.2	3.7	0.1	98.5	1.5	–
	192	91.0	8.9	0.1	92.2	6.8	1.0	96.5	3.5	–
	200	85.7	13.5	0.8	88.9	9.4	1.7	94.9	5.1	–
	218	82.0	16.7	1.3	85.4	10.1	4.5	97.4	2.6	–
	234	97.2	2.8	–	81.3	8.5	10.2	100.0	–	–
	243	98.9	1.2	–	80.7	3.2	16.1	100.0	–	–
	251	99.4	0.7	–	81.3	1.1	17.5	99.8	0.2	–
7	187	97.2	2.8	–	96.0	3.8	0.2	97.6	2.4	–
	196	98.9	1.1	–	97.0	2.9	0.1	95.4	4.5	0.1
	205	99.6	0.4	–	96.1	3.8	0.1	95.8	4.1	0.1
	223	99.9	0.1	–	99.5	0.5	–	99.2	0.8	–
	242	100.0	–	–	100.0	–	–	100.0	–	–
	251	100.0	–	–	100.0	–	–	99.8	0.2	–
	260	100.0	–	–	100.0	–	–	99.8	0.2	–
8	190	100.0	–	–	99.9	0.1	–	96.4	3.6	–
	200	100.0	–	–	99.9	0.1	–	95.3	4.7	–
	209	100.0	–	–	99.9	0.1	–	96.2	3.8	–
	229	92.4	7.4	0.2	100.0	–	–	99.9	0.1	–
	248	92.5	7.2	0.3	99.5	0.5	–	99.8	0.2	–
	258	96.9	3.1	–	99.6	0.4	–	99.8	0.2	–
	267	98.6	1.5	–	99.7	0.3	–	99.8	0.2	–
	Min.	80.1	0.1	0.1	80.2	0.1	0.1	94.9	0.1	0.1
	Max.	100.0	18.9	1.3	100.0	13.5	18.2	100.0	5.1	0.1
	Mean	97.0	4.4	0.5	95.6	3.5	7.4	99.2	1.5	0.1
	SD	4.9	5.2	0.4	6.9	3.7	7.5	1.5	1.8	0.0

Table E.2. Content Balancing for On-Grade Simulees—Reading

Grade	True RIT	On-Grade Item Pool			±1 Grade Item Pool			All-Grade Item Pool		
		Balanced	Slightly Unbalanced	Extremely Unbalanced	Balanced	Slightly Unbalanced	Extremely Unbalanced	Balanced	Slightly Unbalanced	Extremely Unbalanced
	145	100.0	–	–	99.9	–	0.1	100.0	–	–
	154	99.7	0.2	0.1	99.9	–	0.1	99.8	–	0.2
	163	99.1	0.7	0.2	99.8	0.1	0.1	99.8	–	0.1
2	180	99.8	–	–	100.0	–	–	100.0	–	–
	198	100.0	–	–	99.9	–	0.1	100.0	–	–
	207	100.0	–	–	100.0	–	–	100.0	–	–
	216	100.0	–	–	100.0	–	–	99.9	–	0.1
	157	100.0	–	–	99.6	0.4	–	99.9	0.1	–
	165	99.9	0.1	–	99.2	0.7	0.1	99.7	0.2	0.1
	174	99.9	0.1	–	99.9	0.1	–	99.8	–	0.2
3	192	99.9	0.1	–	99.9	0.1	–	100.0	–	–
	209	100.0	–	–	100.0	–	–	100.0	–	–
	218	100.0	–	–	100.0	–	–	100.0	–	–
	227	100.0	–	–	100.0	–	–	99.9	0.1	–
	167	97.6	2.0	0.4	99.2	0.8	–	99.6	0.2	0.2
	175	99.9	0.1	–	99.6	0.2	0.2	100.0	–	–
	184	100.0	–	–	99.9	0.1	–	100.0	–	–
4	201	99.9	0.1	–	100.0	–	–	100.0	–	–
	218	100.0	–	–	100.0	–	–	100.0	–	–
	226	100.0	–	–	100.0	–	–	100.0	–	–
	234	100.0	–	–	100.0	–	–	99.4	0.6	–
	174	100.0	–	–	99.6	0.4	–	99.7	–	0.3
	183	99.9	0.1	–	99.8	0.2	–	99.9	–	0.1
	181	99.9	0.1	–	100.0	–	–	100.0	–	–
5	208	100.0	–	–	100.0	–	–	100.0	–	–
	224	100.0	–	–	100.0	–	–	99.9	0.1	–
	232	100.0	–	–	100.0	–	–	99.7	0.3	–
	241	100.0	–	–	100.0	–	–	99.1	0.8	0.1
	180	81.3	8.0	10.7	99.8	0.2	–	100.0	–	–
	188	89.2	6.8	4.0	99.7	0.3	–	100.0	–	–
	196	95.8	3.0	1.2	99.8	0.2	–	100.0	–	–
6	212	100.0	–	–	100.0	–	–	100.0	–	–
	229	100.0	–	–	100.0	–	–	100.0	–	–
	237	100.0	–	–	100.0	–	–	100.0	–	–
	245	100.0	–	–	100.0	–	–	100.0	–	–
	184	82.5	12.2	5.3	89.6	8.0	2.4	100.0	–	–
	192	87.8	8.2	4.0	91.6	5.7	2.7	100.0	–	–
	200	93.8	4.2	2.0	97.3	1.9	0.8	99.9	–	0.1
7	216	100.0	–	–	100.0	–	–	100.0	–	–
	233	100.0	–	–	100.0	–	–	100.0	–	–
	241	100.0	–	–	100.0	–	–	100.0	–	–
	249	100.0	–	–	100.0	–	–	100.0	–	–
	188	63.0	21.4	15.6	90.4	7.2	2.4	100.0	–	–
	196	81.8	12.0	6.2	92.1	5.4	2.5	99.8	–	0.2
	204	95.4	3.1	1.5	98.3	0.9	0.8	99.8	–	0.2
8	220	100.0	–	–	100.0	–	–	100.0	–	–
	237	100.0	–	–	100.0	–	–	100.0	–	–
	245	100.0	–	–	100.0	–	–	100.0	–	–
	253	100.0	–	–	100.0	–	–	100.0	–	–
	Min.	63.0	0.1	0.1	89.6	0.1	0.1	99.1	0.1	0.1
	Max.	100.0	21.4	15.6	100.0	8.0	2.7	100.0	0.8	0.3
	Mean	97.3	4.3	4.3	99.1	1.7	1.0	99.9	0.3	0.2
	SD	7.0	5.8	4.7	2.5	2.7	1.1	0.2	0.3	0.1

Table E.3. Content Balancing for On-Grade Simulees—Language Usage

Grade	True RIT	On-Grade Item Pool			±1 Grade Item Pool			All-Grade Item Pool		
		Balanced	Slightly Unbalanced	Extremely Unbalanced	Balanced	Slightly Unbalanced	Extremely Unbalanced	Balanced	Slightly Unbalanced	Extremely Unbalanced
	147	100.0	–	–	100.0	–	–	100.0	–	–
	155	100.0	–	–	100.0	–	–	100.0	–	–
	164	100.0	–	–	100.0	–	–	100.0	–	–
2	180	100.0	–	–	100.0	–	–	100.0	–	–
	197	100.0	–	–	100.0	–	–	100.0	–	–
	206	100.0	–	–	100.0	–	–	100.0	–	–
	214	100.0	–	–	100.0	–	–	100.0	–	–
	160	100.0	–	–	100.0	–	–	100.0	–	–
	168	100.0	–	–	100.0	–	–	100.0	–	–
	176	100.0	–	–	100.0	–	–	100.0	–	–
3	192	100.0	–	–	100.0	–	–	100.0	–	–
	208	100.0	–	–	100.0	–	–	100.0	–	–
	216	100.0	–	–	100.0	–	–	100.0	–	–
	224	100.0	–	–	100.0	–	–	100.0	–	–
	170	100.0	–	–	100.0	–	–	100.0	–	–
	177	100.0	–	–	100.0	–	–	100.0	–	–
	185	100.0	–	–	100.0	–	–	100.0	–	–
4	201	100.0	–	–	100.0	–	–	100.0	–	–
	216	100.0	–	–	100.0	–	–	100.0	–	–
	224	100.0	–	–	100.0	–	–	100.0	–	–
	231	100.0	–	–	100.0	–	–	100.0	–	–
	177	100.0	–	–	100.0	–	–	100.0	–	–
	184	100.0	–	–	100.0	–	–	100.0	–	–
	192	100.0	–	–	100.0	–	–	100.0	–	–
5	207	100.0	–	–	100.0	–	–	100.0	–	–
	222	100.0	–	–	100.0	–	–	100.0	–	–
	229	100.0	–	–	100.0	–	–	100.0	–	–
	236	100.0	–	–	100.0	–	–	100.0	–	–
	181	100.0	–	–	100.0	–	–	100.0	–	–
	189	100.0	–	–	100.0	–	–	100.0	–	–
	196	100.0	–	–	100.0	–	–	100.0	–	–
6	211	100.0	–	–	100.0	–	–	100.0	–	–
	226	100.0	–	–	100.0	–	–	100.0	–	–
	233	100.0	–	–	100.0	–	–	100.0	–	–
	241	100.0	–	–	100.0	–	–	100.0	–	–
	185	100.0	–	–	100.0	–	–	100.0	–	–
	193	100.0	–	–	100.0	–	–	100.0	–	–
	200	100.0	–	–	100.0	–	–	100.0	–	–
7	215	100.0	–	–	100.0	–	–	100.0	–	–
	230	100.0	–	–	100.0	–	–	100.0	–	–
	237	100.0	–	–	100.0	–	–	100.0	–	–
	244	100.0	–	–	100.0	–	–	100.0	–	–
	189	100.0	–	–	100.0	–	–	100.0	–	–
	196	100.0	–	–	100.0	–	–	100.0	–	–
	204	100.0	–	–	100.0	–	–	100.0	–	–
8	218	100.0	–	–	100.0	–	–	100.0	–	–
	233	100.0	–	–	100.0	–	–	100.0	–	–
	241	100.0	–	–	100.0	–	–	100.0	–	–
	248	100.0	–	–	100.0	–	–	100.0	–	–
	Min.	100.0	–	–	100.0	–	–	100.0	–	–
	Max.	100.0	–	–	100.0	–	–	100.0	–	–
	Mean	100.0	–	–	100.0	–	–	100.0	–	–
	SD	0.0	–	–	0.0	–	–	0.0	–	–

Table E.4. Content Balancing for Off-Grade Simulees—Mathematics

Grade	True RIT	On-Grade Item Pool			±1 Grade Item Pool			All-Grade Item Pool		
		Balanced	Slightly Unbalanced	Extremely Unbalanced	Balanced	Slightly Unbalanced	Extremely Unbalanced	Balanced	Slightly Unbalanced	Extremely Unbalanced
2	133	100.0	–	–	100.0	–	–	100.0	–	–
	138	100.0	–	–	100.0	–	–	100.0	–	–
	142	100.0	–	–	100.0	–	–	100.0	–	–
	216	100.0	–	–	99.4	0.6	–	99.9	0.1	–
	220	100.0	–	–	99.8	0.1	0.1	99.6	0.4	–
	224	100.0	–	–	99.5	0.5	–	99.7	0.3	–
3	151	99.9	0.1	–	100.0	–	–	100.0	–	–
	159	99.3	0.7	–	100.0	–	–	100.0	–	–
	162	99.8	0.2	–	100.0	–	–	100.0	–	–
	228	98.9	1.1	–	99.9	0.1	–	99.5	0.5	–
	232	96.7	3.2	–	99.4	0.5	0.1	99.9	0.1	–
	236	95.4	4.6	–	98.6	1.3	0.1	99.6	0.4	–
4	164	100.0	–	–	99.7	0.3	–	100.0	–	–
	168	100.0	–	–	100.0	–	–	100.0	–	–
	172	99.9	–	–	100.0	–	–	100.0	–	–
	239	99.8	0.2	–	97.5	2.5	–	99.9	0.1	–
	243	99.3	0.7	–	99.0	1.0	–	100.0	–	–
	247	99.5	0.5	–	99.7	0.3	–	100.0	–	–
5	174	99.6	0.4	–	80.8	0.3	18.9	99.9	0.1	–
	176	99.3	0.4	0.3	80.8	0.9	18.3	100.0	–	–
	179	99.3	0.7	–	80.4	0.9	18.7	99.9	0.1	–
	248	95.4	4.6	–	86.7	13.3	–	100.0	–	–
	249	96.9	3.1	–	85.4	14.6	–	100.0	–	–
	251	98.3	1.8	–	83.7	16.3	–	99.9	0.1	–
6	180	96.2	3.8	–	97.2	2.7	0.1	99.4	0.6	–
	181	95.5	4.5	–	97.4	2.5	0.1	98.8	1.2	–
	182	95.0	4.9	0.1	96.7	3.1	0.2	98.8	1.2	–
	254	99.9	0.1	–	82.0	0.5	17.5	99.5	0.5	–
	257	100.0	–	–	82.7	0.2	17.1	99.9	0.1	–
	260	100.0	–	–	84.0	0.2	15.8	99.7	0.4	–
7	183	98.1	1.9	–	98.1	1.9	–	98.5	1.5	–
	184	98.6	1.4	–	97.6	2.3	0.1	98.0	2.0	–
	185	97.7	2.3	–	97.0	2.9	0.1	97.5	2.5	–
	262	99.9	0.1	–	100.0	–	–	99.9	0.1	–
	264	100.0	–	–	100.0	–	–	99.7	0.3	–
	267	100.0	–	–	100.0	–	–	99.6	0.4	–
8	187	100.0	–	–	99.8	0.2	–	97.6	2.4	–
	189	100.0	–	–	99.8	0.2	–	96.8	3.2	–
	190	100.0	–	–	99.9	0.1	–	97.2	2.8	–
	268	98.3	1.7	–	99.4	0.5	0.1	99.6	0.4	–
	269	98.0	2.0	–	99.9	0.1	–	99.6	0.4	–
	270	98.3	1.7	–	99.5	0.5	–	99.6	0.4	–
	Min.	95.0	0.1	0.1	80.4	0.1	0.1	96.8	0.1	–
	Max.	100.0	4.9	0.3	100.0	16.3	18.9	100.0	3.2	–
	Mean	98.9	1.8	0.2	95.7	2.3	7.2	99.4	0.8	–
	SD	1.5	1.6	0.1	6.9	4.3	9.0	0.8	0.9	–

Table E.5. Content Balancing for Off-Grade Simulees—Reading

Grade	True RIT	On-Grade Item Pool			±1 Grade Item Pool			All-Grade Item Pool		
		Balanced	Slightly Unbalanced	Extremely Unbalanced	Balanced	Slightly Unbalanced	Extremely Unbalanced	Balanced	Slightly Unbalanced	Extremely Unbalanced
2	134	19.9	80.1	–	100.0	–	–	100.0	–	–
	138	19.9	80.1	–	100.0	–	–	100.0	–	–
	142	19.9	80.1	–	100.0	–	–	100.0	–	–
	218	18.2	81.8	–	100.0	–	–	100.0	–	–
	223	19.0	81.0	–	100.0	–	–	100.0	–	–
	227	19.7	80.3	–	100.0	–	–	99.9	0.1	–
3	145	100.0	–	–	100.0	–	–	100.0	–	–
	150	100.0	–	–	99.9	0.1	–	99.9	0.1	–
	154	100.0	–	–	99.7	0.3	–	99.8	0.2	–
	229	100.0	–	–	100.0	–	–	99.9	0.1	–
	232	100.0	–	–	100.0	–	–	99.7	0.3	–
	234	100.0	–	–	100.0	–	–	99.2	0.8	–
4	157	90.2	8.4	1.4	99.2	0.8	–	99.9	0.1	–
	161	92.6	6.1	1.3	99.1	0.8	0.1	99.6	0.4	–
	165	96.3	3.3	0.4	99.1	0.6	0.3	99.6	0.2	0.2
	236	100.0	–	–	100.0	–	–	99.8	0.2	–
	238	100.0	–	–	100.0	–	–	98.9	0.9	0.2
	241	100.0	–	–	100.0	–	–	99.2	0.8	–
5	167	100.0	–	–	98.9	1.0	0.1	99.6	0.4	–
	170	100.0	–	–	99.0	0.8	0.2	99.8	0.2	–
	172	100.0	–	–	99.4	0.6	–	99.8	0.2	–
	242	100.0	–	–	100.0	–	–	98.9	1.0	0.1
	244	100.0	–	–	100.0	–	–	99.2	0.7	0.1
	245	100.0	–	–	100.0	–	–	99.3	0.6	0.1
6	174	79.7	7.1	13.2	100.0	–	–	100.0	–	–
	176	80.2	7.6	12.2	99.8	0.2	–	100.0	–	–
	179	82.3	7.1	10.6	100.0	–	–	100.0	–	–
	246	100.0	–	–	100.0	–	–	100.0	–	–
	248	100.0	–	–	100.0	–	–	100.0	–	–
	249	100.0	–	–	100.0	–	–	100.0	–	–
7	180	80.5	12.9	6.6	90.0	8.8	1.2	100.0	–	–
	182	81.7	12.6	5.7	88.9	9.1	2.0	100.0	–	–
	183	81.6	12.4	6.0	89.6	8.5	1.9	100.0	–	–
	250	100.0	–	–	100.0	–	–	100.0	–	–
	252	100.0	–	–	100.0	–	–	100.0	–	–
	253	100.0	–	–	100.0	–	–	100.0	–	–
8	184	58.9	23.0	18.1	88.5	9.5	2.0	100.0	–	–
	186	58.3	25.1	16.6	89.1	8.9	2.0	100.0	–	–
	187	58.4	25.1	16.5	88.9	9.1	2.0	100.0	–	–
	254	100.0	–	–	100.0	–	–	100.0	–	–
	255	100.0	–	–	100.0	–	–	100.0	–	–
	256	100.0	–	–	100.0	–	–	100.0	–	–
	Min.	18.2	3.3	0.4	88.5	0.1	0.1	98.9	0.1	0.1
	Max.	100.0	81.8	18.1	100.0	9.5	2.0	100.0	1.0	0.2
	Mean	82.3	35.2	9.1	98.3	3.9	1.2	99.8	0.4	0.1
	SD	28.5	33.6	6.4	3.8	4.3	0.9	0.3	0.3	0.1

Table E.6. Content Balancing for Off-Grade Simulees—Language Usage

Grade	True RIT	On-Grade Item Pool			±1 Grade Item Pool			All-Grade Item Pool		
		Balanced	Slightly Unbalanced	Extremely Unbalanced	Balanced	Slightly Unbalanced	Extremely Unbalanced	Balanced	Slightly Unbalanced	Extremely Unbalanced
2	134	100.0	–	–	100.0	–	–	100.0	–	–
	138	100.0	–	–	100.0	–	–	100.0	–	–
	142	100.0	–	–	100.0	–	–	100.0	–	–
	216	100.0	–	–	100.0	–	–	100.0	–	–
	220	100.0	–	–	100.0	–	–	100.0	–	–
	224	100.0	–	–	100.0	–	–	100.0	–	–
3	155	100.0	–	–	100.0	–	–	100.0	–	–
	157	100.0	–	–	100.0	–	–	100.0	–	–
	159	100.0	–	–	100.0	–	–	100.0	–	–
	226	100.0	–	–	100.0	–	–	100.0	–	–
	228	100.0	–	–	100.0	–	–	100.0	–	–
	231	100.0	–	–	100.0	–	–	100.0	–	–
4	160	100.0	–	–	100.0	–	–	100.0	–	–
	165	100.0	–	–	100.0	–	–	100.0	–	–
	169	100.0	–	–	100.0	–	–	100.0	–	–
	232	100.0	–	–	100.0	–	–	100.0	–	–
	234	100.0	–	–	100.0	–	–	100.0	–	–
	236	100.0	–	–	100.0	–	–	100.0	–	–
5	170	100.0	–	–	100.0	–	–	100.0	–	–
	173	100.0	–	–	100.0	–	–	100.0	–	–
	176	100.0	–	–	100.0	–	–	100.0	–	–
	237	100.0	–	–	100.0	–	–	100.0	–	–
	239	100.0	–	–	100.0	–	–	100.0	–	–
	241	100.0	–	–	100.0	–	–	100.0	–	–
6	177	100.0	–	–	100.0	–	–	100.0	–	–
	179	100.0	–	–	100.0	–	–	100.0	–	–
	180	100.0	–	–	100.0	–	–	100.0	–	–
	242	100.0	–	–	100.0	–	–	100.0	–	–
	243	100.0	–	–	100.0	–	–	100.0	–	–
	244	100.0	–	–	100.0	–	–	100.0	–	–
7	181	100.0	–	–	100.0	–	–	100.0	–	–
	183	100.0	–	–	100.0	–	–	100.0	–	–
	184	100.0	–	–	100.0	–	–	100.0	–	–
	245	100.0	–	–	100.0	–	–	100.0	–	–
	247	100.0	–	–	100.0	–	–	100.0	–	–
	248	100.0	–	–	100.0	–	–	100.0	–	–
8	185	100.0	–	–	100.0	–	–	100.0	–	–
	186	100.0	–	–	100.0	–	–	100.0	–	–
	188	100.0	–	–	100.0	–	–	100.0	–	–
	249	100.0	–	–	100.0	–	–	100.0	–	–
	250	100.0	–	–	100.0	–	–	100.0	–	–
	251	100.0	–	–	100.0	–	–	100.0	–	–
	Min.	100.0	–	–	100.0	–	–	100.0	–	–
	Max.	100.0	–	–	100.0	–	–	100.0	–	–
	Mean	100.0	–	–	100.0	–	–	100.0	–	–
	SD	0.0	–	–	0.0	–	–	0.0	–	–

Figure E.1. Item RIT Distribution by Instructional Area—Mathematics Grade 5 Item Pool

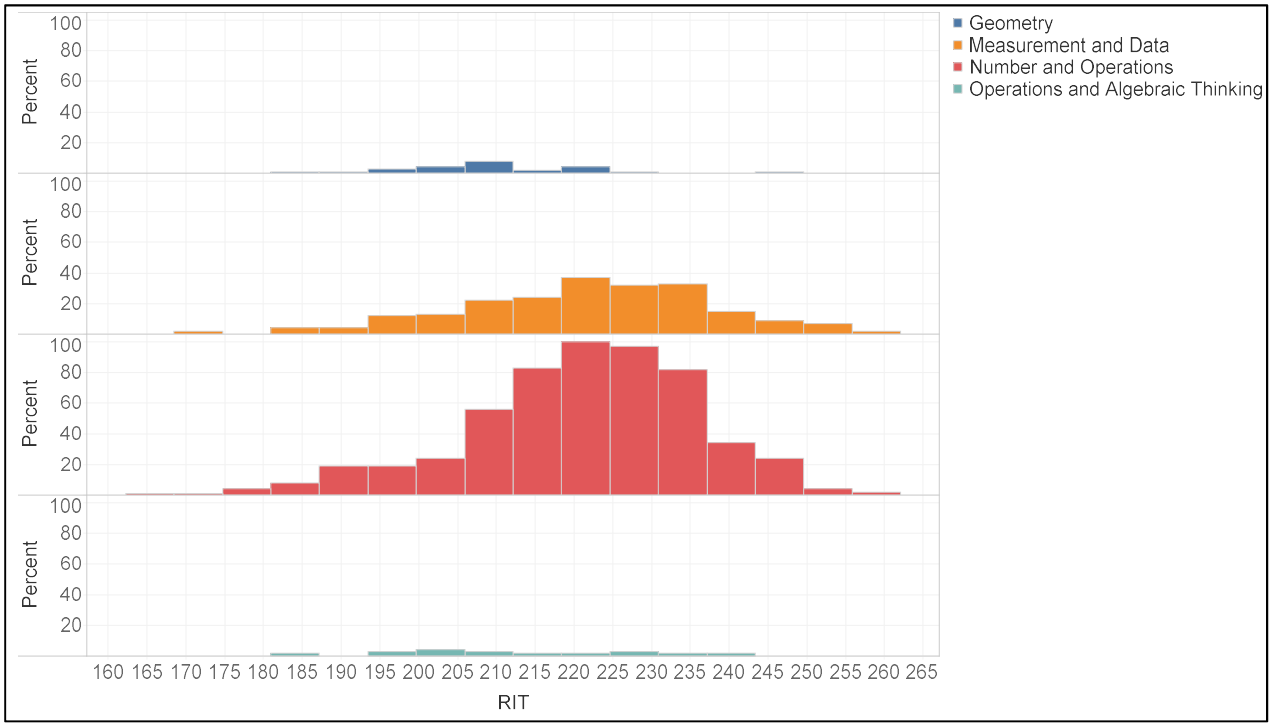

Figure E.2. Item RIT Distribution by Instructional Area—Mathematics Grade 6 Item Pool

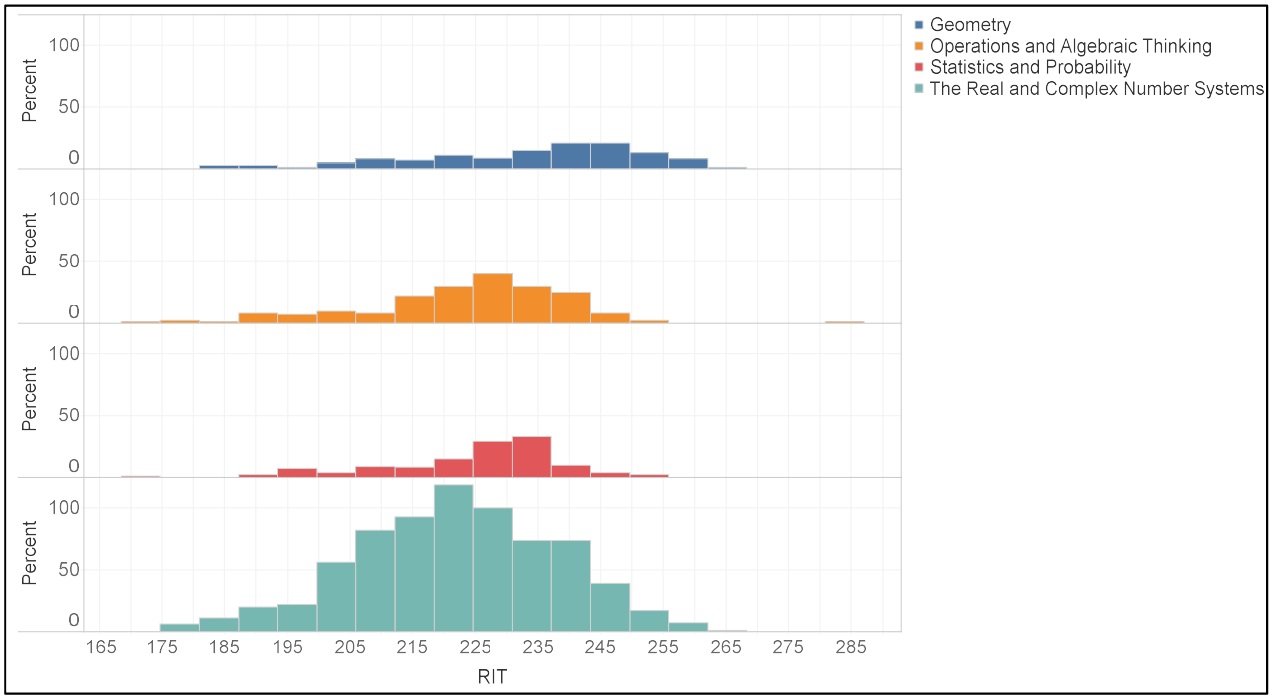

Figure E.3. Item RIT Distribution by Instructional Area—Mathematics Grade 8 Item Pool

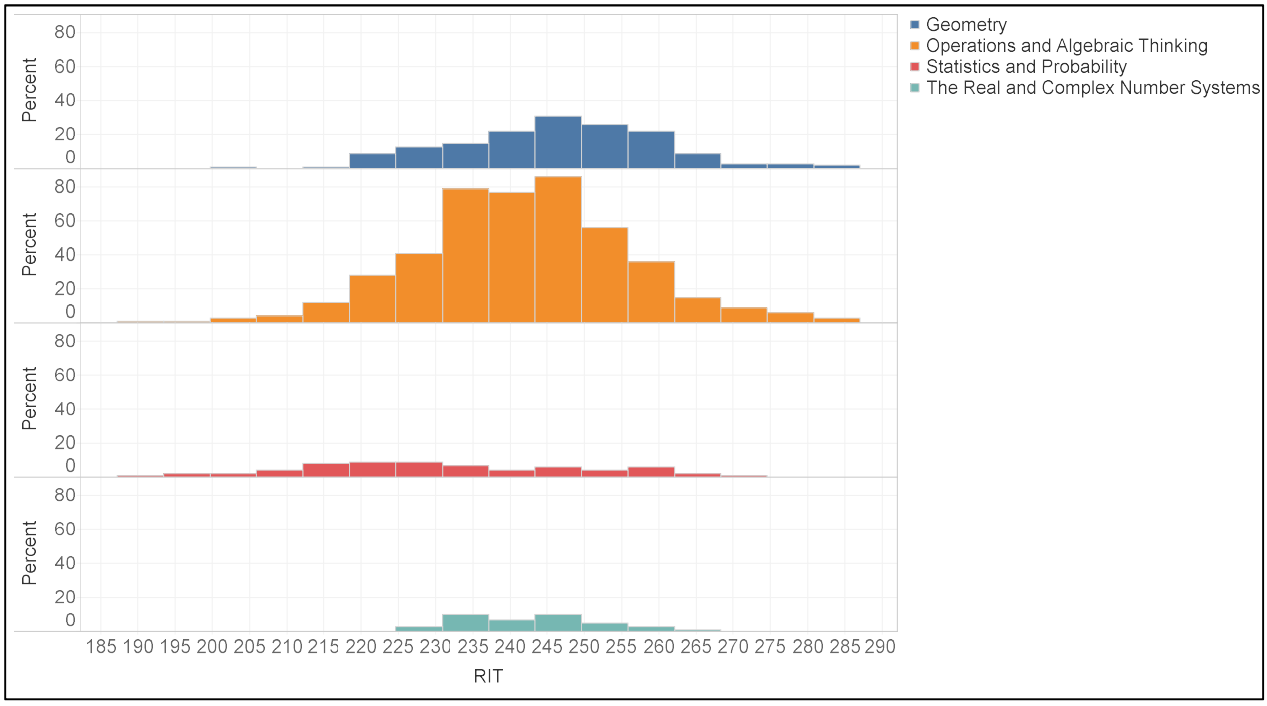

Figure E.4. Item RIT Distribution by Instructional Area—Reading Grade 6 Item Pool

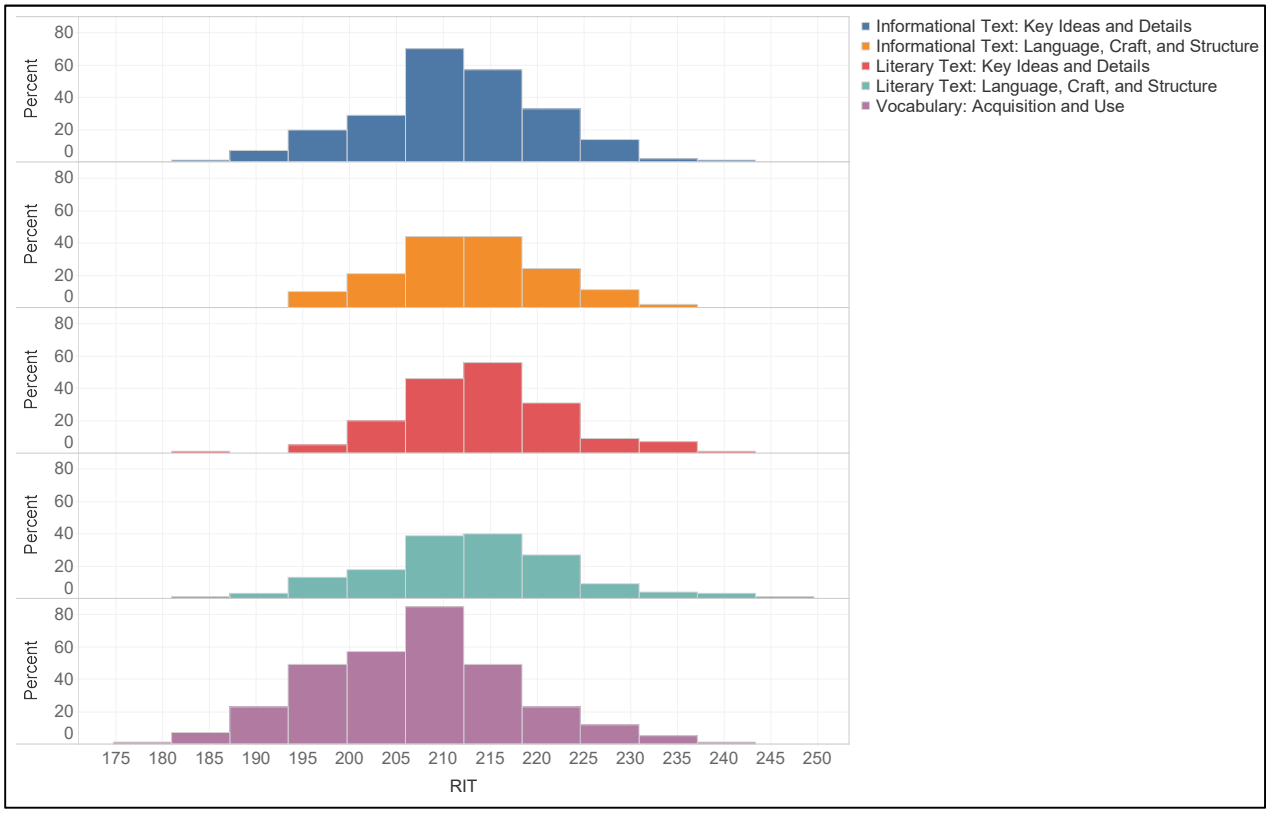

Figure E.5. Item RIT Distribution by Instructional Area—Reading Grade 7 Item Pool

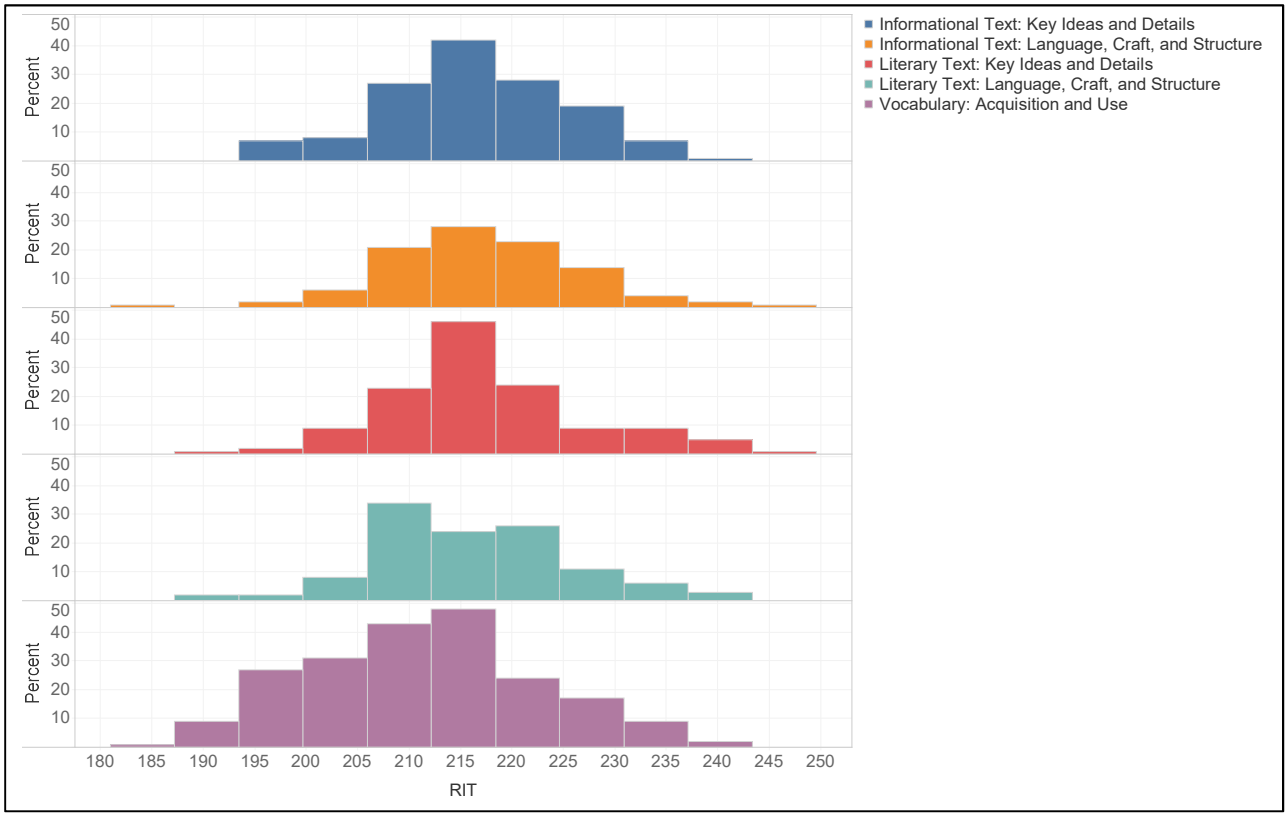

Figure E.6. Item RIT Distribution by Instructional Area—Reading Grade 8 Item Pool