

**Alignment of the SAT Mathematics Items and the MCAP Algebra I Items to
the Maryland Algebra I College and Career Ready Standards**

**Submitted to
Maryland State Department of Education (MSDE)**

**By
Maryland Assessment Research Center**

December 2023

Executive Summary

The purpose of this study is to evaluate the rigor of the SAT math test compared with the Maryland Comprehensive Assessment Program (MCAP) Algebra I test for the high school graduation assessment requirement in Maryland. Specifically, an alignment study of the SAT mathematics items to the Maryland Algebra I College and Career Ready (CCR) Standards was conducted. The study was designed to evaluate the extent to which the SAT items are aligned with the Maryland Algebra I CCR Standards and the depth of knowledge (DOK) levels of the SAT items against those of the MCAP Algebra I items. The similarities and the differences between the SAT math items and MCAP Algebra I items were quantified to evaluate the content representation and the rigor of each test against the Maryland Algebra I content standards.

A group of panelists was recruited to participate in the alignment study. A training session was conducted before the alignment session. Three forms of SAT mathematics tests were examined including one SAT linear form and two SAT digital forms. The two SAT digital forms are multistage adaptive forms with one targeting at the lower-difficulty level (labeled as Form 1) while the other targeting at the higher-difficulty level (labeled as Form 2). The alignment session evaluated 58 math items in the SAT linear form, 40 math items in each SAT digital form, and 36 MCAP Algebra I items. For each form, different rounds of ratings and discussions were carried out by the panelists. The alignment results were further cross-validated by national and Maryland state content experts with multiple rounds of discussions as well. In-depth discussions among all three parties including the panelists, the national expert, and the Maryland experts were carried out before consensus among all parties was reached. The major findings of this alignment study presented below are based on the final cross-validated alignment results in terms of content standards and the DOK levels.

Major Findings

The details of this alignment study are documented in this report. The following summarizes the major findings of this study.

1. The Maryland Algebra I College and Career Ready Standards covers 4 content domains: Number and Quantity (NQ), Algebra (A), Functions (F), and Statistics (S). Among the four domains, 10 subdomains are identified associated with the above four content domains respectively as 2 for NQ, 4 for A, 3 for F, and 1 for S.
2. Four forms were included in this alignment study: one SAT linear form, two SAT digital forms, and one MCAP Algebra I form. For the alignment of items on each form, the same procedure was followed. The agreement among the panelists increased after each round of discussion. Perfect agreement was reached after the validation discussion.
3. Among the 58 SAT linear form items, 42 items were aligned to the Maryland Algebra I standards while 16 items were aligned to the standards related to Algebra II, high-school Statistics, or Geometry. Among the 40 items on the SAT digital form 1 targeting at the lower-difficulty level, 30 items were aligned to the Maryland Algebra I standards while 10 items were aligned to the standards related to Algebra II, high-school Statistics, Geometry, or Pre-Algebra. Among the 40 items on the SAT digital form 2 targeting at the

higher-difficulty level, 25 items were aligned to the Maryland Algebra I standards while 15 items were aligned to the standards related to Algebra II, high-school Statistics, Geometry, Pre-Calculus, or Pre-Algebra. All 36 MCAP items were aligned to one or more Maryland Algebra I standards.

4. All alignment results are summarized on the Algebra I items only on each test form, namely 42 items on the SAT linear form, 30 items on the SAT digital form 1, 25 items on the SAT digital form 2, and 36 MCAP Algebra I items.
5. When items are double or multiple-coded on different standards, each standard is counted separately. The SAT linear form, the SAT digital form 1 and form 2 contains 44, 36, and 27 counts of the Maryland Algebra I standards respectively while the MCAP Algebra I test contains 46 counts of the standards. The summary presented below is based on the standard count.
6. The 42 Algebra I items with 44 standard counts on the **SAT linear form** cover 8 of the 10 Maryland Algebra I standards including
 - 1) quantities (3 standard counts, 6.8%),
 - 2) seeing structure in expressions (1 standard count, 2.3%),
 - 3) arithmetic with polynomials and rational expressions (3 standard counts, 6.8%),
 - 4) creating equations (11 standard counts, 25.0%),
 - 5) reasoning with equations and inequalities (12 standard counts, 27.3%),
 - 6) interpreting functions (8 standard counts, 18.2%),
 - 7) linear, quadratic, and exponential functions (2 standard counts, 4.5%), and
 - 8) interpreting categorical and quantitative data (4 standard counts, 9.1%).

The 2 standards not covered by the SAT linear test form are

- 1) real number system (0 standard counts, 0%), and
- 2) building functions (0 standard counts, 0%).

The 30 Algebra I items with 36 standard counts on the **SAT digital form 1** cover 8 of the 10 Maryland Algebra I standards including

- 1) seeing structure in expressions (4 standard count, 11.1%),
- 2) arithmetic with polynomials and rational expressions (2 standard counts, 5.6%),
- 3) creating equations (8 standard counts, 22.2%),
- 4) reasoning with equations and inequalities (8 standard counts, 22.2%),
- 5) interpreting functions (6 standard counts, 16.7%),
- 6) building functions (1 standard count, 2.8%),
- 7) linear, quadratic, and exponential functions (6 standard counts, 16.7%), and
- 8) interpreting categorical and quantitative data (1 standard count, 2.8%).

The 2 standards not covered by the SAT digital form 1 are

- 1) quantities (0 standard counts, 0%), and
- 2) the real number system (0 standard counts, 0%).

The 25 Algebra I items with 27 standard counts on the **SAT digital form 2** cover 8 of the 10 Maryland Algebra I standards, including

- 1) seeing structure in expressions (3 standard count, 11.1%),
- 2) arithmetic with polynomials and rational expressions (1 standard count, 3.7%),
- 3) creating equations (5 standard counts, 18.5%),
- 4) reasoning with equations and inequalities (6 standard counts, 22.2%),
- 5) interpreting functions (7 standard counts, 25.9%),
- 6) building functions (2 standard count, 7.4%),

- 7) linear, quadratic, and exponential functions (2 standard count, 7.4%), and
- 8) interpreting categorical and quantitative data (1 standard count, 3.7%).

The 2 standards not covered by the SAT digital form 2 are

- 1) quantities (0 standard counts, 0%), and
- 2) the real number system (0 standard counts, 0%).

The 36 **MCAP** items with 46 standard counts aligned cover 9 of the 10 standards, including

- 1) quantities (2 standard counts, 4.3%),
- 2) seeing structure in expressions (3 standard counts, 6.5%),
- 3) arithmetic with polynomials and rational expressions (1 standard count, 2.2%),
- 4) creating equations (3 standard counts, 6.5%),
- 5) reasoning with equations and inequalities (12 standard counts, 26.1%),
- 6) interpreting functions (10 standard counts, 21.7%),
- 7) building functions (1 standard count, 2.2%),
- 8) linear, quadratic, and exponential functions (8 standard counts, 17.4%), and
- 9) interpreting categorical and quantitative data (6 standard counts, 13.0%).

The standard that was not covered by the MCAP items is

- 1) real number system (0 standard counts, 0%).

7. The distributions of the DOK levels are different between the 42 items on the SAT linear form and the 36 MCAP items. For the SAT linear form, the numbers of items at DOK levels 1 to 4 are 2, 35, 5, and 0 with the respective percentages of 4.8%, 83.3%, 11.9%, and 0%. The numbers of MCAP items at DOK levels 1 to 4 are 4, 26, 6, and 0 with the respective percentages of 11.1%, 72.2%, 16.7%, and 0%. The SAT linear form contained lower percentages of items at both DOK levels 1 and 3 but a higher percentage of items at DOK level 2. No item in either the SAT linear form or MCAP test was aligned to DOK level 4. Furthermore, 27.6% of the items on this form are from advanced math topics (e.g., Geometry, Algebra II, or high-school Statistics). Counting SAT items assessing more advanced math topics, 96.6% of the items on the SAT linear form are more challenging than DOK level 1 while 88.9% of the MCAP items are more challenging than DOK level 1.
8. The distribution of the DOK levels of the 30 items on the SAT digital form 1 is different from that for the 36 MCAP items. The numbers of SAT items at DOK levels 1 to 4 are 9, 18, 3, and 0 with the respective percentages of 30.0%, 60.0%, 10.0%, and 0%. In general, the SAT digital form 1 contained a higher percentage of items at DOK level 1 and lower percentages of items at DOK levels 2 and 3. Like the MCAP test, no item in the SAT digital form 1 was aligned to DOK level 4. Further, 17.5% of the items on this form are from advanced math topics (e.g., Geometry, Algebra II, or high-school Statistics). Counting SAT items assessing more advanced math topics, 70.0% of the items on the SAT digital form 1 are more challenging than DOK level 1 (compared to MCAP, 88.9%).
9. The distribution of the DOK levels of the 25 items on the SAT digital form 2 is different from that for the 36 MCAP items. The numbers of SAT items at DOK levels 1 to 4 are 1, 18, 5, and 1 with the respective percentages of 4.0%, 72.0%, 20.0%, and 4.0%. The SAT digital form 2 contained a lower percentage of items at DOK level 1 but a higher percentage of items at DOK level 3. The percentages of items at DOK level 2 are similar between the two tests. More importantly, the SAT digital form 2 contains one DOK level 4 item, indicating higher rigor. Further, 27.5% of the items on this form are from

advanced math topics (e.g., Geometry, Algebra II, high-school Statistics, or Pre-Calculus). Counting SAT items assessing more advanced math topics, 87.5% of the items on the SAT digital form 2 are more challenging than DOK level 1 (compared to MCAP, 88.9%).

10. In summary, the three SAT forms have different levels of rigor compared with the MCAP Algebra I test form as follows.
 - a. SAT linear form covers 8 out of 10 Maryland Algebra I Standards with additional coverage of content standards in Geometry, Algebra II, and high-school statistics. Compared with the MCAP Algebra I test, this linear form takes more weight on two domains: *Number and Quantity*, and *Algebra* but less weight on the *Function* and *Statistics* domains. The DOK level distributions are also different, with the SAT linear form containing lower percentages of items assessing levels 1 and 3 and a higher percentage of items assessing level 2. The rigor of this form is close to or higher than the MCAP Algebra I test considering more items on advanced math topics.
 - b. SAT digital form 1 targeting at the lower-difficulty level covers 8 out of 10 Maryland Algebra I Standards with additional coverage of content standards in Pre-Algebra, Geometry, Algebra II, and high-school Statistics. Compared with the MCAP Algebra I test, this digital form covers more weights in the *Algebra* but less weight in the *Function* and *Statistics* domains. No items assess the *Number and Quantity* domain. The DOK level distributions are different, with a higher percentage of items assessing lower DOK level 1 but lower percentages of items assessing DOK levels 2 and 3. Even with the addition of items assessing more advanced math topics, the rigor of this form is lower than the MCAP Algebra I test.
 - c. SAT digital form 2 targeting at the higher-difficulty level covers 8 out of 10 Maryland Algebra I Standards with additional coverage of content standards in Pre-Algebra, Geometry, Algebra II, high-school Statistics and Pre-Calculus. Compared with the MCAP Algebra I test, higher percentages of items assessing DOK levels 2 and 3 including one item for DOK level 4 but a lower percentage of items at DOK level 1. With the addition of items on more advanced topics, the rigor of this SAT form is about the same as or higher than the MCAP test.
11. Each of the SAT forms misses 2 of 10 substandards. If the two missing Algebra I standards should carry some weight in the evaluation of the Algebra I assessment requirement (though the Algebra II, high-school statistics, and Geometry, even Pre-Calculus standards are assessed in the SAT math), additional source of information such as Algebra I course grades could be considered to supplement SAT math scores to assure the full coverage of the Maryland Algebra I College and Career Ready standards.
12. Based on the four evaluation criteria often used in an alignment study, the items on the SAT linear form are comparable to items on the MCAP Algebra I test in terms of *Categorical Concurrence*, *Depth-of-Knowledge*, and *Range-of-Knowledge* except the Statistics domain partially met the Categorical Concurrence. The same issue was observed for the items on the two SAT digital forms. In addition, items on the two SAT digital forms did not meet the three criteria in the *Number and Quantity* domain as no items were aligned to this domain for these two forms. In terms of *Balance of Representation* (BOR), the SAT digital form 1 targeting at the lower difficulty level met

the criterion at each domain with items assessing it. The SAT digital form 2 targeting at the higher difficulty level almost met the criterion in the three assessed domains with a BOR value slightly below 0.70 for the *Functions* domain. In general, the SAT linear did not meet this criterion almost in each content domain. The MCAP Algebra I test did not achieve a good balance of representation using the BOR index.

13. The findings related to content standard alignment from this study are consistent with the results from other alignment studies conducted for Florida, Delaware, Maine, and Connecticut, which indicated that SAT math items did not fully cover their state standards.
14. The findings from this study regarding the DOK levels indicated that the items on the SAT linear form and SAT digital form 1 spanned from low to middle cognitive demand (i.e., DOK levels 1 to 3), which is consistent with the Florida alignment study. On the other hand, the items on the SAT digital form 2 spanned from low to high cognitive demand (i.e., DOK levels 1 to 4). The discrepancy may be due to the use of different SAT test forms.