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RESEARCH IN MATHEMATICS EDUCATION

Imagination Station (Istation):

**Universal Screener Instrument Development for
Grade 2**

RESEARCH IN
MATHEMATICS
EDUCATION

Technical Report 13-01

Imagination Station (Istation): Universal Screener Instrument Development for Grade 2

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Abstract

In this technical report, we describe the development of the Grade 2 formative assessment item bank for Imagination Station (Istation). The formative assessment item bank will be used to deliver a computerized adaptive universal screening assessment to support teachers' instructional decision-making. State and national mathematics content standards for Grade 2 inform the construct underlying the items. In this technical report, we describe the process used to identify and sample the mathematics content and levels of cognitive complexity assessed in the item bank. Next, we describe the item writing procedures. Finally, we describe how the external item review process and outcomes contributes to content-related evidence for validity.

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Imagination Station (Istation): Universal Screener Instrument Development for Grade 2

Introduction

The purpose of the Grade 2 formative assessment item bank for Imagination Station (Istation) is to support teachers' instructional decision-making. The formative assessment item bank is a computerized adaptive universal screening assessment system to identify students' understanding of fundamental mathematics skills and grade level standards. By administering this assessment system, teachers and administrators can use the results to answer two questions: (1) Are students at risk of failure in Grade 2 mathematics, and (2) What is the degree of intensity of instructional support students need to be successful in Grade 2 mathematics? Multiple administrations of the universal screener (i.e., fall, winter, and early spring each year) provide teachers with meaningful information about students' learning over time to support instructional decision-making over the course of Grade 2. The universal screener is designed for administration to all students receiving grade-level instruction.

The purpose of this technical report is to describe the development of the formative assessment item bank. This description includes (a) the process used to identify and sample the mathematics content assessed in the item bank, (b) the item writing process, and (c) the external review process and results. The test development steps used to create the formative assessment item bank represent best practices in test development and align with the Test Standards published by the American Educational Research Association (AERA), American Psychological Association (APA), and National Council on Measurement in Education (NCME) (1999).

Construct Definition

The assessed construct consists of (a) mathematics content and (b) levels of cognitive engagement (National Research Council [NRC], 2001). The mathematics content of the Grade 2 formative assessment item bank is based on the Curriculum Focal Points (CFP) (National Council of Teachers of Mathematics [NCTM], 2006), Common Core State Standards for Mathematics (CCSSM), and state content standards from California, Texas, Florida, New York, and Virginia. See Appendix A for the state content standards. The CCSSM and state content standards were aligned to NCTM's focal points. A fourth CFP was created to include ten content standards that were assessed across the states and in the CCSSM but were not represented in the NCTM focal points. This CFP includes geometry standards (e.g., classifying solids, decomposing two-dimensional shapes, and identifying shapes). See Appendix B for an abbreviated description of the assessed content.

To develop the assessment blueprint, experienced mathematics educators and mathematics researchers engaged in discussions and worked iteratively to align the state content standards to NCTM's focal points and to identify each content standard as *high-priority*, *secondary*, or *not assessable*. *High-priority* standards are skills that were critical to assess because they serve as the foundation for skills that are essential to a student's future success with mathematics. *Secondary* standards are skills that are important for Grade 2 mathematics but are not as foundational for future mathematics concepts. *Not assessable* standards are skills that could not be assessed using an online multiple-choice assessment. These determinations were made based on expert opinion and were verified by at least two members of the Research in Mathematics Education staff, all of whom have extensive mathematics education experience. In total, 50 standards were identified as *high-priority*, 38 as *secondary*, and two as *not assessable*. The standards identified as *high-priority* are highlighted yellow in Appendix B. The standards identified as *secondary* are white. The standards identified as *not assessable* are highlighted grey.

The cognitive engagement dimension of the construct refers to the level of cognitive processing through which students are expected to engage with the content. The formative assessment item bank uses the taxonomy of cognitive engagement in mathematics published by the NRC (2001). The taxonomy consists of five interdependent strands that promote mathematical proficiency: (a) conceptual understanding, (b) procedural fluency, (c) strategic competence, (d) adaptive reasoning, and (e) productive disposition. Items in the formative assessment item bank assess student understanding of the content at four levels of cognitive engagement; items were not written to assess a student's productive disposition of mathematics. A brief description of each level follows:

1. *Conceptual understanding* pertains to the functional grasp of mathematics that a student applies to concepts, operations, and relations. It involves being able to logically organize one's knowledge to integrate and understand concepts as part of a coherent whole.
2. *Procedural fluency* pertains to students' ability to accurately and appropriately carry out skills, including being able to select efficient and flexible approaches.
3. *Strategic competence* involves one's ability to formulate a problem in mathematical terms, to represent it strategically (verbally, symbolically, graphically, or numerically), as well as to solve it effectively. It is similar to problem solving and problem formation.
4. *Adaptive reasoning* involves the student's capacity to think logically about a problem, which requires reflecting on various approaches to solve a problem and deductively selecting an approach. Students who are able to do this are also able to rationalize and justify their strategy.

5. *Productive disposition* refers to a student’s overall ability to perceive mathematics as worthwhile and to maintain a personal belief in one’s own efficacy in solving problems.

Each CFP was assessed at the four levels of cognitive engagement. Conceptual understanding and procedural fluency were oversampled to accurately reflect the relative emphasis in the state standards at Grade 2. Easy, medium, and difficult items were written for each high-priority standard in each CFP across the four levels of cognitive engagement. The level of difficulty of each item is a relative description that is subject to change with empirical analyses.

Approximately eight to nine items were written for each high-priority standard. Secondary standards were incorporated into items assessing high-priority content. The content sampling matrix is presented in Figure 1.

Item Writing

Item Specifications

Approximately 400 items were written for Grade 2. Multiple-choice items were created for efficiency in the computer delivery system. Each item had three distractors and one correct answer. Items were written for dichotomous scoring as either correct or incorrect. The distractors represent plausible misconceptions or errors in conceptual or procedural understanding.

The item stem included text and/or graphics. A concerted effort was made to ensure that the language was grade-level appropriate; however, readability statistics were not calculated for each item. Whenever possible, plain language and simple, straightforward statements were incorporated into the items. Graphics were used in instances where they explained the problem, provided a visual clue to clarify the context, or were integral to the stem or answer choices. Irrelevant graphics were not included.

The assessment items were written according to the principles of universal design for assessment (see Ketterlin-Geller, 2005; 2008) and are amenable to accommodations. As delivered, the formative assessment system will include a read aloud feature to support item readability. This ensures that mathematics knowledge and skills are tested, rather than students’ reading skills.

The computerized-adaptive test can be administered individually or in a group in an untimed setting.

Item Writers

Twenty item writers contributed to the Grade 2 formative assessment item bank. In the following paragraphs we describe each item writer’s qualifications and relevant previous experience.

Item Writer 1. Item Writer 1 holds a B.S. in Elementary Education and has 22 years of experience in education. For the past 10 years, she has served as a Master Teacher for her

district. She has over 800 hours of continuing education credits from the state of Texas and has been awarded over 20 district awards for leadership and service. She has also been named Teacher of the Year.

Item Writer 2. Item Writer 2 holds a B.A. in Elementary Education and a M.Ed. in Curriculum and Instruction. She is also a Texas state certified Master Reading Teacher. Currently, she is a Ph.D. candidate at Southern Methodist University where she has worked on several technology-based assessment and professional development grants. Before entering the doctoral program, she spent over 18 years as a classroom teacher and administrator. As the Director of Curriculum at a PK-8 school of over 800 children she developed academic and professional development programs, mentored teachers, administered formative and summative teacher evaluations, and supervised the administration of assessments in reading and mathematics.

Item Writer 3. Item Writer 3 holds a B.S. in Mathematics Education. She taught high school Geometry and Pre-Calculus for three years. While teaching, she earned her M.Ed. degree in Mathematics Curriculum and Instruction. She also tutors students in subjects ranging from eighth grade mathematics to Pre-Calculus. She currently serves as the Professional Development Coordinator for the Research in Mathematics Education unit at Southern Methodist University.

Item Writer 4. Item Writer 4 received a B.S. of Interdisciplinary Studies and a M.A. in Curriculum and Instruction. She currently teaches middle school mathematics and has been teaching for 17 years, 16 of those in elementary school. She has also served as a campus Assessment Specialist at two elementary schools and has extensive experience delivering mathematics professional development. She was also named Teacher of the Year at two different elementary campuses.

Item Writer 5. Item Writer 5 received a B.A. in Mathematics and a M.Ed. in Educational Leadership and Policy Studies. She taught elementary and middle school mathematics for four years. She also served at the Texas Education Agency for three years in a variety of roles, including the Assistant Director of Mathematics and Mathematics Curriculum Specialist in the Curriculum Division and Mathematics Assessment Specialist in the Student Assessment Division. She is currently pursuing her doctoral degree at Southern Methodist University.

Item Writer 6. Item Writer 6 holds a B.S. in Elementary Education. She currently serves as a district K-12 Mathematics Coordinator and previously served as a Lead Instructional Coach, Curriculum Support Specialist, Elementary Mathematics Specialist, and an elementary and middle school teacher. She also has participated in multiple assessment projects, writing items for state assessments and participating in state-level assessment committees.

Item Writer 7. Item Writer 7 received a B.A. in Government and a M.S.T. in Childhood Education. She taught elementary and middle school students in Brooklyn, Houston, and Washington, D.C. She also served as a Professor of Teacher Education and Child Development at community colleges in Houston. She is currently pursuing her doctoral degree at Southern Methodist University.

Item Writer 8. Item Writer 8 holds a B.S. in Education and a M.Ed. in Educational Administration. She currently serves as a mathematics and science District Instructional Specialist where she assists in the development of assessment items and district curriculum. Before serving in this capacity, she taught for nine years in elementary, middle, and high school.

Item Writer 9. Item Writer 9 holds a B.S. in Interdisciplinary Studies – Mathematics and a M.Ed. and holds certifications in K–12 administration and conflict resolution. She is currently the Assessment Coordinator for the Research in Mathematics Education unit at Southern Methodist University. Prior to coming to Southern Methodist University, she worked as an Elementary Mathematics Specialist, coaching and supporting teachers in the classrooms. She also taught mathematics in Grades 4–8 and has worked on a variety of national, state, and local assessment projects.

Item Writer 10. Item Writer 10 received a B.S. in Elementary Education with a specialization in Special Education and a M.Ed. in Education. She is certified to teach English as a Second Language, Elementary, and Special Education and is a certified Master Mathematics Teacher and Master Technology Teacher. She taught preschool through sixth grade. She is currently the Elementary Mathematics Coordinator for the Research in Mathematics Education unit at Southern Methodist University.

Item Writer 11. Item Writer 11 holds a B.S. in Academic Studies and a Master’s in Secondary and Higher Education. She has been in education for 18 years and currently serves as an early childhood school counselor. Previously, she served as a mathematics specialist, instructional facilitator, and mathematics teacher. She has also presented over 20 professional development sessions at schools, regional service centers, and state conferences.

Item Writer 12. Item Writer 12 received a B.A. in Psychology and a M.A. in Education and Dispute Resolution and Conflict Management. She has taught third and fourth grade mathematics for three years.

Item Writer 13. Item Writer 13 holds a B.S. in Psychology and a Master’s of Library Science. He has written mathematics benchmark items for a large urban district and is currently a library/media specialist. Previously, he taught fifth grade mathematics, science, and language arts for 10 years.

Item Writer 14. Item Writer 14 holds a B.S. in Mathematics Education and a M.A. in Interdisciplinary Studies. She taught high school mathematics and has been involved in multiple curriculum and assessment projects. As a secondary mathematics facilitator, she assisted teachers with curriculum, instruction, and student engagement. She is currently the Mathematics Research Coordinator for the Research in Mathematics Education unit at Southern Methodist University.

Item Writer 15. Item Writer 15 holds a B.A. in Art History and a Master's of Liberal Arts. She taught Spanish to elementary school students and has experience in mathematics education research. She is currently a Project Specialist for the Research in Mathematics Education unit at Southern Methodist University.

Item Writer 16. Item Writer 16 holds a B.A. and a M.Ed. in Educational Administration. She currently serves as an administrator for an early childhood education center. Previously, she taught middle school mathematics and science for 12 years. She has led numerous professional development opportunities for her school district and serves on curriculum writing and school improvement committees. She has also been named Teacher of the Year three times.

Item Writer 17. Item Writer 17 holds a B.A in Psychology, Masters degrees in Counseling Psychology, Special Education, and School Psychology, and a Ph.D. in Educational Leadership. After graduating, she worked for a nonprofit organization where she assisted in the design, development, and evaluation of education programs and improvement initiatives. She later worked as a school psychologist where she conducted comprehensive psycho-educational evaluations to determine student eligibility for special services and to inform interventions. She currently works as a special education program specialist for a school district.

Item Writer 18. Item Writer 18 holds a B.S. in Education and a M.Ed. in Educational Administration. She has seven years of teaching experience; six years teaching kindergarten and one year teaching fourth grade. She also served several campus leadership positions in mathematics and assessment.

Item Writer 19. Item Writer 19 holds a B.A. in Art History and a Master's in Education. She is a Teach for America corps member and has been teaching for three years. She serves on the Curriculum Instructional Leadership Team to assist in gathering and interpreting school assessment data. She has also served as a Grade Level Chair for her school.

Item Writer 20. Item Writer 20 holds a B.S. in Education and a M.Ed. in Education. She has served as an educational diagnostician for three years and taught pre-school and kindergarten for five years.

Item Writing Training

Prior to the item-writing workshop, item writers were asked to review the Grade 2 blueprint to become familiar with the content standards and levels of cognitive complexity. Research in Mathematics Education staff created a video describing how to read the blueprint and provided to all item writers to assist them with this task.

All item writers attended an item-writing workshop to learn how to write items that align with the content expectations and item specifications. Item writers received training from recognized experts in item design, as well as information on the elements of high-quality test design, how to write high-quality mathematics items, and guidelines for writing selected response items. Moreover, writers received sample items illustrating important components of high-quality items and discussed how problematic items could be improved. Item writers were given an Item Writing Manual that described principles of universal design for assessment and logistical information about formatting, reviewing, and submitting items. A glossary of useful terms and a list of relevant websites were provided.

Item Writing Process

After participating in the item-writing training, item writers were given the item-writing template to create items. Upon completion of the items, item writers submitted items to researchers and project staff for review. Each item submitted during the workshop was reviewed by at least one project team member to ensure that the item included all of the required components. Reviewers evaluated items for (a) mathematical accuracy, (b) alignment with the content standards, (c) age-appropriateness of language and graphics for students in Grade 2, and (d) compliance with universal design principles. Items requiring revision with regard to these components were returned to the item writers with specific comments and suggestions for revising the item; once revised, item writers resubmitted their items for approval. All finalized items were cross-referenced to the test blueprint and specifically to the content standards to ensure that the Grade 2 content was adequately represented. When possible, secondary standards were incorporated into items that assessed high-priority content.

Once items were accepted, item level information was entered into an Item Database. The item writers and staff at the Research in Mathematics Education unit created initial graphics for the items, which were recreated and/or finalized by the Istation graphic design team. The finalized items were copy-edited and reviewed by Research in Mathematics Education staff and Istation staff.

Content-Related Evidence for Validity

Mathematicians and mathematics teachers evaluated all items for accuracy and appropriateness of the content written for the formative assessment item bank for students in Grade 2.

Mathematician Review

Three mathematicians reviewed all items in Grade 2. Two reviewers are professors of mathematics at universities in Texas and hold undergraduate and graduate degrees in mathematics. The third mathematician is an assistant professor of mathematics at a university in Oregon and holds an undergraduate degree in mathematics and graduate degrees in mathematics education. Their experience in mathematics education and research ranges from 11-19 years. Two reviewers are female, and all reviewers are Caucasian.

The mathematicians were each asked to review 133–134 items and evaluate the accuracy of the content, precision of the vocabulary, and effectiveness of distractors. The criteria used for item evaluation were as follows:

- Mathematical accuracy of content: Is the item mathematically accurate?
- Precision of mathematical vocabulary: Is the mathematical vocabulary used accurately? Is the mathematical vocabulary precise?
- Appropriateness of the distractors: Most students use a process of elimination to narrow their options in the context of multiple-choice questions. The purpose of selecting appropriate distractors is to reduce the likelihood of students with misconceptions from choosing a correct answer in the elimination process. Are the distractors appropriate for the item? Are the distractors mathematically plausible misconceptions?

Items and distractors were evaluated on a 4-point scale for each criterion. A rating of 1 indicated that the item was not accurate, precise, or appropriate; a rating of 2 indicated that the item was somewhat accurate, precise, or appropriate; a rating of 3 indicated that the item was mostly accurate, precise, or appropriate; and a rating of 4 indicated the item was extremely accurate, precise, or appropriate. In instances where the reviewer assigned a score of 1 or 2 for any criterion, recommendations were solicited that would aid in revision.

Overall, the mathematicians rated the majority of the items as mostly to extremely accurate, precise, and effective. Their ratings can be seen in Figure 2. Approximately, 56% of the “somewhat appropriate” or “not appropriate” ratings (i.e., 1s and 2s) were due to graphics not rendering properly. The mathematicians recommended changing distractors to reflect more plausible student misconceptions, mathematical vocabulary to be more precise, and language to be more accessible for all students. For any item that received a rating of 1 or 2, the research team considered each suggestion and revised the items in response to their recommendations.

Teacher Review

Three teachers with elementary mathematics experience reviewed the items. One reviewer is a second grade teacher, has five years of teaching experience, and holds a Bachelor’s degree.

Another reviewer is a special education teacher, has 13 years of education-related experience, holds Bachelor's and Master's degrees, and has served as a district mathematics coordinator. The third reviewer is an elementary instructional facilitator, has 26 years of education-related experience, and holds a Bachelor's degree, two Master's degrees, and is currently pursuing a doctorate in curriculum and instruction. All teacher reviewers are female and Caucasian.

The teacher reviewers were each asked to review 133–134 items and analyzed each item for appropriate grade-level language and vocabulary, content or concepts, graphics, clarity of directions and answers, and effectiveness of distractors. The criteria presented for item evaluation were as follows:

- Appropriateness of language: Is the language used in the item appropriate for students in your grade level? Are the question and response options written so that students in your grade level can understand the meaning of the problem?
- Appropriateness of mathematical vocabulary: Is the mathematical vocabulary representative of pre-requisite or instructional expectations in your grade level?
- Appropriateness of content or concepts: Is the task representative of prerequisite or instructional expectations in your grade level?
- Appropriateness of visual representation: Is the visual representation (i.e., graphic, table, image) used in the item appropriate for students in your grade level? Can students in your grade level understand the meaning of the visual representation? Is the visual representation of the item clear?
- Appropriateness of the distractors: Some students use an eliminating process to narrow their options in the context of multiple-choice questions. The purpose of selecting appropriate distractors is to reduce the likelihood of students with misconceptions from choosing a correct answer in the elimination process. Are the distractors appropriate for the item? Do the distractors discriminate between students with specific misconceptions?

The items and distractors were rated on a scale of 1 to 4 for each criterion. A rating of 1 indicated that the item/distractors were not at all appropriate based on the criterion; a rating of 2 indicated that the item/distractors were somewhat appropriate based on the criterion; a rating of 3 indicated that the item/distractors were appropriate based on the criterion; and a rating of 4 indicated that the item/distractors were extremely appropriate based on the criterion. In instances where the teachers provided a rating of 2 or lower, they were asked to provide additional suggestions and comments to improve the item.

Teachers also analyzed each item for potential bias in language and/or content. The criterion for potential bias were as follows:

- Bias in language or content: Does the item require background knowledge unrelated to

the concept being tested that would differ for students with different backgrounds? Is the language sensitive to students from diverse backgrounds, students with limited English proficiency and students with special needs?

- Example: “*What is the most appropriate measurement unit for the length of a **sub** or **hoagie**?*” may be unfair for students in certain geographic regions and students with diverse background who are unfamiliar with these terms.

Teachers were asked to rate each item as Not Biased, Somewhat Biased, or Biased. In instances where the teachers identified items as Biased, they were asked to provide additional suggestions and comments to improve the item.

Overall, the teachers rated the items as mostly to extremely appropriate in regard to language, vocabulary content, visual representation, bias, and effectiveness of distractors. Their ratings can be seen in Figure 3 and Figure 4. Approximately, 40% of the “somewhat appropriate” or “not appropriate” ratings (i.e., 1s and 2s) were due to graphics not rendering properly. The teachers recommended changing contexts within items to prevent bias, distractors to reflect more plausible student misconceptions, visuals to increase clarity, and language to be more accessible for all students. For any item that received a rating of 1 or 2, the research team reviewed all suggestions and made revisions based on teacher feedback.

Conclusion

The purpose of this technical report was to describe the development of the formative assessment item bank for Grade 2. We described the components of the assessed construct—content standards and levels of cognitive complexity—and the process for sampling the content assessed in the formative assessment item bank. Next, we described the item writing procedures and provided the qualifications for the item writers. Finally, we documented the process and outcomes of an external item review by mathematicians and mathematics teachers to contribute to content-related evidence for validity.

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Figure 1*Content Sampling Matrix*

CFP	Procedural fluency			Conceptual understanding			Strategic competence			Adaptive reasoning		
	Easy	Medium	Difficult	Easy	Medium	Difficult	Easy	Medium	Difficult	Easy	Medium	Difficult
1	15	13	13	13	13	13	0	13	0	0	13	0
2	13	12	12	13	12	12	0	12	0	0	12	0
3	18	16	16	16	16	16	0	16	0	0	16	0
4	10	8	8	8	8	8	0	8	0	0	8	0
Total By Difficulty	56	49	49	50	49	49	0	49	0	0	49	0

Figure 2*Expert Review Ratings*

		Mathematical Accuracy	Precise Vocabulary	Appropriateness of Distractors
Expert Reviewer 1	4 – Extremely appropriate	123	130	125
	3 – Mostly appropriate	0	2	6
	2 – Somewhat appropriate	0	0	1
	1 – Not appropriate	10	1	0
Expert Reviewer 2	4 – Extremely appropriate	125	129	129
	3 – Mostly appropriate	0	0	0
	2 – Somewhat appropriate	1	3	1
	1 – Not appropriate	8	2	4
Expert Reviewer 3	4 – Extremely appropriate	118	114	110
	3 – Mostly appropriate	2	1	5
	2 – Somewhat appropriate	10	15	15
	1 – Not appropriate	3	3	3

Figure 3*Teacher Review Ratings*

		Language	Math Vocabulary	Content	Visuals	Distractors
Teacher Reviewer 1	4 – Extremely appropriate	116	115	107	114	112
	3 – Mostly appropriate	17	17	13	10	12
	2 – Somewhat appropriate	0	1	3	4	3
	1 – Not appropriate	0	0	10	5	6
Teacher Reviewer 2	4 – Extremely appropriate	56	52	56	74	46
	3 – Mostly appropriate	55	70	76	46	83
	2 – Somewhat appropriate	20	6	2	2	2
	1 – Not appropriate	3	6	0	12	3
Teacher Reviewer 3	4 – Extremely appropriate	98	79	66	50	45
	3 – Mostly appropriate	26	32	22	12	21
	2 – Somewhat appropriate	5	14	19	18	18
	1 – Not appropriate	4	8	21	29	37

Figure 4

Teacher Review Ratings for Bias

		Number of Items
Teacher Reviewer 1	Not biased	131
	Somewhat biased	2
	Biased	0
Teacher Reviewer 2	Not biased	134
	Somewhat biased	0
	Biased	0
Teacher Reviewer 3	Not biased	120
	Somewhat biased	7
	Biased	6

Appendix A - State Content Standards Referent Sources

National Council of Teachers of Mathematics (NCTM) Curricular Focal Points

The National Council of Teachers of Mathematics (NCTM) Curricular Focal Points were retrieved from http://www.nctmmedia.org/cfp/front_matter.pdf on 4/20/2010. Additional information was also retrieved on 4/20/2010 from: www.nctm.org/focalpoints.

Florida

Florida's Next Generation Sunshine State Math Standards (adopted 2010) were retrieved on 6/13/2012 from <http://www.cpalms.org/Downloads.aspx>. These standards include the Common Core Standards in Mathematics.

California

California's Common Core Content Standards for Mathematics (adopted 2010) were retrieved from http://www.scoe.net/castandards/agenda/2010/math_ccs_recommendations.pdf. These standards include the Common Core Standards in Mathematics.

New York

The New York State P-12 Common Core Learning Standards for Mathematics were retrieved on from: <http://engageny.org/sites/default/files/resource/attachments/nysp12cclsmath.pdf>. These standards include the Common Core Standards in Mathematics plus additional state-specific standards.

Texas

The Texas Essential Knowledge and Skills (adoption 2012) were retrieved from: <http://ritter.tea.state.tx.us/rules/tac/chapter111/index.html>.

Common Core Standards

The Common Core Standards in Mathematics were retrieved on June 10, 2011 from <http://www.corestandards.org/the-standards/mathematics>. These standards were published in 2010. They were developed as part of an initiative led by National Governors Association Center for Best Practices (NGA Center) and the Council of Chief State School Officers (CCSSO).

Virginia

Virginia's Standards for Learning Document for Mathematics (adopted 2009 for full implementation in 2011-12) were retrieved from http://www.doe.virginia.gov/testing/sol/standards_docs/mathematics/.

Appendix B - Content Description

GRADE 2 MATHEMATICS CURRICULUM FOCAL POINTS	
CFP 1: Number and Operations	
Developing an understanding of the base-ten numeration system and place-value concepts	
2.1A.1	Children develop an understanding of the base-ten numeration system and place value concepts (at least to 1000).
2.1A.2	Count within 1000; skip-count by 5s, 10s, and 100s.
2.1B.1	Their understanding of base-ten numeration includes ideas of counting in units and multiples of hundreds, tens, and ones, as well as a grasp of number relationships, which they demonstrate in a variety of ways, including comparing and ordering numbers.
2.1B.2	Generate a number that is greater than or less than a given whole number up to 1,200.
2.1B.3	Use an understanding of place value [relationships] to determine the number that is 10 or 100 more or less than a given number up to 1,200.
2.1B.4	The student will round two-digit numbers to the nearest ten.
2.1B.5	The student will a) identify the ordinal positions first through twentieth, using an ordered set of objects; and b) write the ordinal numbers.
2.1B.6	Compare two three-digit numbers based on meanings of the hundreds, tens, and ones digits, using $>$, $=$, and $<$ symbols to record the results of comparisons.
2.1C.1	They understand multi-digit numbers in terms of place value , recognizing that place-value notation is a shorthand for the sums of multiples of powers of 10 (e.g., 853 as 8 hundreds + 5 tens + 3 ones).
2.1D.1	Children use place value and properties of operations to create equivalent representations of given numbers (such as 35 represented by 35 ones, 3 tens and 5 ones, or 2 tens and 15 ones) and to write, compare, and order multi-digit numbers.
2.1E.1	They use these ideas [place value and properties of operations] to compose and decompose multi-digit numbers.
2.1E.2	Add up to four two-digit numbers using strategies based on place value and properties of operations .
2.1E.3	Add and subtract within 1000, using concrete models or drawings .
2.1E.4	Explain why addition and subtraction strategies work, using place value and the properties of operations.
2.1E.5	Add and subtract within 1000, using strategies based on place value ; relate the strategy to a written method.
2.1E.6	Add and subtract within 1000, using properties of operations , and/or the relationship between addition and subtraction; relate the strategy to a written method.
2.1E.7	Understand that in adding or subtracting three-digit numbers, one adds or subtracts hundreds and hundreds, tens and tens, ones and ones; and sometimes it is necessary to compose or decompose tens or hundreds.
2.1F.1	Partition objects into equal parts and name the parts, including halves, fourths, and eighths, using words
2.1F.2	Explain that the more fractional parts used to make a whole, the smaller the part; and the fewer the fractional parts, the larger the part.

KEY: Yellow: High-priority standards

White: Secondary standards

Grey: Not assessable standards

2.1F.3	Use concrete models to count fractional parts beyond one whole using words and recognize how many parts it takes to equal one whole.
2.1F.4	Identify examples and non-examples of halves, fourths, and eighths.
2.1F.5	The student will a) identify the parts of a set and/or region that represent fractions for halves, thirds, fourths, sixths, eighths, and tenths; b) write the fractions; and c) compare the unit fractions for halves, thirds, fourths, sixths, eighths, and tenths.
CFP 2: Number and Operations and Algebra	
Developing quick recall of addition facts and related subtraction facts and fluency with multi-digit addition and subtraction	
2.2B.1	They solve arithmetic problems by applying their understanding of models of addition and subtraction (such as combining or separating sets or using number lines).
2.2B.2	Locate the position of a given whole number on an open number line.
2.2B.3	Name the whole number that corresponds to a specific point on a number line.
2.2B.4	Represent whole-number sums and differences within 100 on a number line diagram.
2.2B.5	They solve arithmetic problems by applying their understanding of relationships and properties of numbers (such as place value).
2.2B.6	They solve arithmetic problems by applying their understanding of properties of addition (commutativity and associativity).
2.2C.1	Children develop, discuss, and use efficient, accurate, and generalizable methods to add and subtract multi-digit whole numbers.
2.2C.2	Generate and solve problem situations for a given mathematical number sentence involving addition and subtraction of whole numbers within 1,000.
2.2D.1	They select and apply appropriate methods to estimate sums and differences or calculate them mentally , depending on the context and numbers involved.
2.2E.1	They develop fluency with efficient procedures, including standard algorithms, for adding and subtracting whole numbers, understand why the procedures work (on the basis of place value and properties of operations), and use them to solve problems.
2.2E.2	Children add and subtract to solve a variety of problems, including applications involving measurement, geometry, and data, as well as non-routine problems.
2.2E.3	Use addition and subtraction within 100 to solve one-step word problems involving situations of adding to, taking from, putting together, taking apart, and comparing, with unknowns in all positions, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem.
2.2E.4	Use addition and subtraction within 100 to solve two-step word problems involving situations of adding to, taking from, putting together, taking apart, and comparing, with unknowns in all positions, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem.
2.2F.1	Determine whether a group of objects (up to 20) has an odd or even number of members, e.g., by pairing objects or counting them by 2s.
2.2F.2	Write an equation to express an even number as a sum of two equal addends.
2.2F.3	The student will demonstrate an understanding of equality by recognizing that the symbol = in an equation indicates equivalent quantities and the symbol \neq indicates that quantities are not equivalent.

KEY: Yellow: High-priority standards
Grey: Not assessable standards

White: Secondary standards

2.2G.1	Use addition to find the total number of objects arranged in rectangular arrays with up to 5 rows and up to 5 columns.
2.2G.2	Write an equation to express the total as a sum of equal addends [in a rectangular array with up to 5 rows and 5 columns].
2.2H.1	In preparation for grade 3, they solve problems involving multiplicative situations, developing initial understandings of multiplication as repeated addition.
2.2H.2	Use repeated subtraction and equal group sharing to demonstrate division.
2.2I.1	Children use number patterns to extend their knowledge of properties of numbers and operations. For example, when skip counting, they build foundations for understanding multiples and factors.

CFP 3: Measurement

Developing an understanding of linear measurement and facility in measuring lengths

2.3A.2	Children develop an understanding of the meaning and processes of measurement, including such underlying concepts as transitivity (e.g., if object A is longer than object B and object B is longer than object C, then object A is longer than object C).
2.3B.1	They understand linear measure as an iteration of units.
2.3B.2	Find the length of objects using concrete models for standard units of length.
2.3B.3	They use rulers and other measurement tools with their understanding of linear measure as an iteration of units.
2.3B.4	Use concrete models of square units to find the area of a rectangle by covering it with no gaps or overlaps, counting to find the total number of square units, and describing the measurement using a number and the unit.
2.3C.1	They understand the need for equal length units .
2.3C.2	They understand the use of standard units of measure (centimeter and inch).
2.3C.3	They understand the inverse relationship between the size of a unit and the number of units used in a particular measurement (i.e., children recognize that the smaller the unit, the more iterations they need to cover a given length).
2.3D.1	Children measure lengths as they solve problems involving data, space, and movement through space.
2.3D.2	Measure to determine how much longer one object is than another, expressing the length difference in terms of a standard length unit.
2.3D.3	Children compute lengths as they solve problems involving data, space, and movement through space.
2.3D.4	Use addition and subtraction within 100 to solve word problems involving lengths that are given in the same units, e.g., by using drawings (such as drawings of rulers) and equations with a symbol for the unknown number to represent the problem.
2.3E.1	Children estimate lengths as they solve problems involving data, space, and movement through space.
2.3E.2	Verify reasonableness of the estimate when working with measurements (e.g., closest inch).
2.3E.3	The student will estimate and measure weight/mass of objects in pounds/ounces and kilograms/grams, using a scale.
2.3E.4	The student will estimate and measure liquid volume in cups, pints, quarts, gallons, and liters.
2.3F.1	Represent whole numbers as lengths from 0 on a number line diagram with equally spaced points corresponding to the numbers 0, 1, 2, ...

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2.3G.1	Tell and write time from analog and digital clocks to the nearest five minutes, using a.m. and p.m. Know relationships of time (e.g., minutes in an hour, days in a month, weeks in a year).
2.3G.2	The student will determine past and future days of the week.
2.3G.3	The student will identify specific days and dates on a given calendar.
2.3G.4	The student will read the temperature on a Celsius and/or Fahrenheit thermometer to the nearest 10 degrees.
2.3G.5	Determine the value of a collection of coins up to one dollar.
2.3G.6	Solve word problems involving combinations of dollar bills, quarters, dimes, nickels, and pennies, using \$ and ¢ symbols appropriately. Example: If you have 2 dimes and 3 pennies, how many cents do you have?
2.3H.1	Generate measurement data by measuring lengths of several objects to the nearest whole unit, or by making repeated measurements of the same object.
2.3H.2	Show measurement data by making a line plot, where the horizontal scale is marked off in whole-number units.
2.3H.3	Explain that the length of a bar in a bar graph or the number of pictures in a pictograph represents the number of data points for a given category.
2.3H.4	Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories.
2.3H.5	Solve simple put-together, take-apart, and compare problems using information presented in a bar graph.
2.3H.6	Draw conclusions and make predictions from information in a graph.
2.3H.7	The student will use data from experiments to predict outcomes when the experiment is repeated.
2.3.I.1	Calculate how money saved can accumulate into a larger amount over time.
2.3.I.2	Explain that saving is an alternative to spending.
2.3.I.3	Distinguish between a deposit and a withdrawal.
2.3.I.4	Identify examples of borrowing and distinguish between responsible and irresponsible borrowing.
2.3.I.5	Identify examples of lending and use concepts of benefits and costs to evaluate lending decisions.
2.3.I.6	Differentiate between producers and consumers and calculate the cost to produce a simple item.
<i>Geometry Standards and their Connections to Focal Points</i>	
2.4A.01	The student will identify, describe, compare, and contrast plane and solid geometric figures (circle/sphere, square/cube, and rectangle/rectangular prism).
2.4A.02	Recognize and draw shapes having specified attributes, such as a given number of angles or a given number of equal faces. [Sizes are compared directly or visually, not compared by measuring.] Identify triangles, quadrilaterals, pentagons, hexagons, and cubes.
2.4A.1	By composing two-dimensional shapes (intentionally substituting arrangements of smaller shapes for larger shapes), they use geometric knowledge and spatial reasoning to develop foundations for understanding area, fractions, and proportions.
2.4A.2	By decomposing two-dimensional shapes (intentionally substituting larger shapes for many smaller shapes), they use geometric knowledge and spatial reasoning to develop foundations for understanding area, fractions, and proportions.

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2.4A.3	Partition circles and rectangles into two, three, or four equal shares, describe the shares using the words halves, thirds, half of, a third of, etc., and describe the whole as two halves, three thirds, four fourths.
2.4A.4	Recognize that equal shares of identical wholes need not have the same shape.
2.4B.1	Classify and sort three-dimensional solids, including spheres, cones, cylinders, rectangular prisms (including cubes as special rectangular prisms), and triangular prisms, based on attributes using formal geometric language.
2.4B.2	Classify and sort polygons with 12 or fewer sides according to attributes, including identifying the number of sides and number of vertices.
2.4B.3	Compose two-dimensional shapes and three-dimensional solids with given properties or attributes.
2.4C.1	The student will draw a line of symmetry in a figure.
2.4C.2	The student will identify and create figures with at least one line of symmetry.

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