

## Testing the Knowledge of Early Childhood Educators

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### Abstract

*Teacher certification exams are supposed to assess if a student is likely to succeed in teaching. What if an exam seems to be inappropriate? This article is an inquiry of the New York State Content Specialty Test for Early Childhood Candidates, particularly the math section. It raises the issue of whether we are asking the right questions and ascertaining the right data to decide if someone has the appropriate math knowledge and is ready to teach math to young children.*

“Dr. McCarthy, can you help me? I just failed the early childhood math CST.” I get emails like this every semester. While most teacher candidates pass the math section of the early childhood Content Specialty Test (CST) on their first try, others struggle. The candidates that struggle are often excellent early childhood educators; the ones we would want to teach our own children. So, does the early childhood math CST really assess what it takes to be a great early childhood educator, especially in math? Is it assessing the pedagogical content knowledge (PCK), particularly in mathematics, that is germane to teaching young children? Should we be testing like this?

Early childhood education Birth-Grade 2 is a unique field. Teachers may work with toddlers in a childcare setting, preschoolers in Head Start, first graders in a school setting, or one of many other situations. Preparing teachers for these settings includes course work in child development, pedagogy, and content. Certification in New York State in early childhood education from Birth-Grade 2 requires candidates to pass certification exams that test their abilities to plan, implement and assess children’s learning with attention to every child’s unique circumstance and rate of development. Certification for early childhood educators is considered important to raising the reputation of the profession. With this in mind, the National Association

of Education of Young Children (NAEYC) has added greater emphasis on content knowledge. This is indicated by Standard 5 of the NAEYC Professional Preparation Standards; it is titled “Using Content Knowledge to Build Meaningful Curriculum.”

It is not just knowing content that is important but using that content knowledge to implement a curriculum that is appropriate and meaningful for young children. The teacher needs to know how to manipulate the content to create learning experiences that motivate and facilitate curiosity. To be sure that professional educators possess appropriate knowledge in the content area, certification exams have been implemented to test educators before licensure. This manuscript describes a systematic investigation, or inquiry, of the questions asked of early childhood teacher candidates on a CST in mathematics given in New York State.

### **An Explanation of the Content Specialty Test**

New York State teacher candidates applying for certification from Birth-Grade 2 must pass a content specialty test known as the multi-subject: teachers of early childhood exam. Candidates are expected to pass all three sections of the exam, they are: English Language Arts, Mathematics, and Arts & Sciences. The test framework for each section and the sample questions are available on the New York State Teacher Certification Website ([www.nystce.nesinc.com](http://www.nystce.nesinc.com), at the time of this publication). These exams are administered by Pearson.

While no one would argue that early childhood educators need to be knowledgeable in many areas including English language arts, mathematics, and arts & science, the sections of the exams do not measure the same type of knowledge. While the math exam tests the same content knowledge required of K-8 students and even includes some high school level math content, the

English language arts exam is set up to test the PCK appropriate for Birth-Grade 2 teachers, the knowledge often taught in teacher preparation programs. The arts & sciences section includes content from the K-college experience from the areas of science, technology, social studies, fine arts, health and fitness, family and consumer science, and career development, but not PCK in these areas. It is interesting to note that the arts & sciences section of the test is included in all the multi-subject exams and only needs to be passed once, even if a candidate is earning other certifications where a multi-subject exam is required. A teacher candidate applying for two certification areas that require the multi-subject content specialty test must pass the English language arts section *and* the math section for each certification area. While this article focuses on the early childhood multi-subject exam, there are three other multi-subject examinations that are taken based on the certification the candidate is applying for, childhood 1-6, middle childhood 5-9, and secondary 7-12.

In the following section, I compared the frameworks, sample questions found on certification exam websites, and questions found on the eighth grade New York state exams in English language arts and math. My findings were surprising.

### ***A Comparison of the English Language Arts and the Math Sections of the Multi-subject CST***

The multi-subject exam is divided into the ELA test, known as section 1 and the math test, known as section 2. They consist of selected response questions, commonly referred to as multiple choice questions and a constructed response question commonly referred to as an essay question.

Pedagogical content knowledge is an interesting construct that is important to understand when considering the CST. Lee Shulman (1986) discussed both teacher examinations and

content knowledge in his article *Those Who Understand: Knowledge Growth in Teaching*. This classic article explains the bridge between content knowledge and pedagogical knowledge by defining pedagogical content knowledge. Shulman describes pedagogical content knowledge (PCK) as the knowledge of subject matter for teaching. He writes, “I still speak of content knowledge here, but of the particular form of content knowledge that embodies the aspects of content most germane to its teachability” (1986, p. 9). PCK includes knowing and understanding the content so that an educator can choose the best examples, representations, and analogies to use with their students and promote understanding. An educator can possess content knowledge in an area and not possess PCK.

When a teacher candidate possesses PCK, they understand the nuances of learning a topic including where their students’ challenges are generally found, the preconceptions they are likely to possess, and they can assess whether a child understands yet. A teacher candidate would also know the many instructional tools that would help children learn a topic. The constructed response question, or the essay question, includes a teaching scenario and student work that is used to answer a question. The constructed response items on the CST seem to test pedagogical content knowledge and this is consistent between the ELA and the math sections. The selected response questions may or may not test pedagogical content knowledge.

According to the test frameworks found on the New York State teacher certification website, it appears that the ELA section is focused on pedagogical content knowledge appropriate for teachers of early childhood while the math section is focused mostly on content knowledge of mathematics. The selected response items for the ELA section account for 70% of the score and the constructed response items account for 30%. The selected response items for

the math section account for 80% of the score and the constructed response items account for 20%.

**Analysis of the ELA Section of the CST.** I noticed that the ELA exam, part 0002 and part 0003, both refer to “instruction,” one in foundational literacy skills and one in English language arts. This would seem to indicate that these two sections test pedagogical content knowledge. This would make the ELA section of the early childhood multi-subject exam 70% pedagogical content knowledge, not the 30% as indicated in the description of the test. Sample questions can be found on the New York State Teacher Certification website. I was unable to secure permission from Pearson to include such items in this manuscript, so I wrote two questions complete with answers (see Figure 1) that present a comparable idea with different and distinct terms to those found in the online preparation materials for the multi-subject CST. Please note, my items were not vetted and analyzed. The items found on the website and on the test would have gone through a vetting process before approval.

### **Figure 1**

*Sample Questions That are Comparable to the Preparation Materials to the Preparation Materials for the English Language Arts Section of the Early Childhood Multi-Subject CST.*

- (1.) Which of the following are characteristics of a learner at the emergent literacy stage, typically 4-6 years old?
- A. Pretending to read books.
  - B. Using pictures and context clues to figure out words.
  - C. Self-correcting when what they read does not make sense.
  - D. Reading to learn new information.

(2.) When a child can recognize and segment the individual sounds in a word, she/he possesses:

- A. phonemic awareness.
- B. alphabetic skills awareness.
- C. graphic awareness.
- D. decoding awareness.

Instruction seems central to the ELA sample questions.

**Analysis of the Math Section of the CST.** The mathematics exam, part 0004, says instruction in mathematics is about 10% of the selected response section of the exam. This along with the constructed response make the math exam 30% pedagogical content knowledge. It is interesting to note that the math topics for the other areas of the exam, numbers and operations, operations and algebraic thinking, measurement, geometry, and data, are like the math topics taught not just in early childhood, but throughout the K-12 experience. The ELA section doesn't include English Language Arts topics found throughout the K-12 experience.

Again, I wrote two questions (see Figure 2) that are akin to the math preparation materials found on the New York State Teacher Certification Exam website. Note that neither question mentions instruction, nor includes topics that are typically taught in early childhood math, Birth-Grade 2. Question 1 requires an understanding of similar triangles and proportionality taught in middle school and high school geometry, concepts aligned with the Next Generation Standards (<https://www.nysed.gov/sites/default/files/programs/curriculum-instruction/nys-next-generation-mathematics-p-12-standards.pdf>, URL at the time of publication).

## Figure 2

### *Sample Questions That are Comparable to the Preparation Materials for the Math Section of the Early Childhood Multi-Subject CST*

(1.) There are two similar triangles. The smaller one measures 7, 10 and 12. The smallest side of the larger triangle is 21. What is the measure of the other two sides of the larger triangle?

- A. 30, 36
- B. 24, 26
- C. 20, 24
- D. 40, 48

(2.) Which number sentence does not equal -12

- A.  $-3(-4)$
- B.  $-14 + 2$
- C.  $-10 + -2$
- D.  $-24/2$

It can be concluded that the ELA section of the CST tests pedagogical content knowledge and the Math section tests math content knowledge. This can be confusing to teacher candidates who have developed appropriate pedagogical content knowledge for math for Birth-Grade 2 certification because they are being tested on math content that is from their middle and high school experiences.

Where are the questions about important math content that is developed at the early childhood level such as sorting, comparing, patterning, counting, and spatial relationships?

Where is the language of the field such as subitizing, cardinality, and one-to-one correspondence? Where are the test questions on the development of math knowledge through trajectories or using frameworks like the Van Hiele Levels of geometric thought?

### **The Importance of Pedagogical Content Knowledge (PCK)**

One might think that the more mathematics content knowledge a teacher possesses the better their students will perform. This is not the case; majoring in math does not make a K-6 math teacher better at teaching math than those who do not major in math (Thames and Ball, 2010). The knowledge required for teaching, particularly for young children, is not tied to extensive content knowledge, but to nuances in the content knowledge for the age and grade level of their students. Teachers need, according to Thames and Ball, to be able to: (1.) pose questions, (2.) explain concepts & assess student explanations, (3.) choose or design tasks, (4.) choose & use representations, (5.) record work on the board, (6.) sequence examples, (7.) analyze errors, (8.) facilitate discussion, (9.) use and define mathematical terms, and (10.) use mathematical notation. It is complex knowledge, yet is it assessed on the math section of the CST? If we want to be sure we have early childhood educators who are prepared to teach mathematics to young children, then we need to assess their abilities in the ten areas Thames and Ball delineated.

### **A Comparison of the CST to the New York State Eighth Grade Exams**

When one compares the topics of the two areas of the content specialty exam to the topics on the New York State eighth grade exam, one sees connections in math, but not in English language arts. At the time of publication, standards and released exam questions can be found here: ([www.nysed.gov/curriculum-instruction/engageny](http://www.nysed.gov/curriculum-instruction/engageny)). The math section of the CST seems to



align with the eighth-grade exam while the ELA section does. An eighth grade ELA standard, for example, states that *students should be able to determine the meaning of words and phrases as they are used in a text including figurative and connotative meanings*. Figure 3 shows a grade 8 test question I wrote that is comparable to those found on the exam and on *EngageNY*, a New York State curriculum.

### **Figure 3**

*Question Comparable to the Eighth Grade English Language Arts Exam Released Questions*

(1.) To *validate* her hypothesis, Samantha did research on the library database and reviewed data she found on reputable websites online.

In this context validate means:

- A. check the accuracy of.
- B. declare legality of.
- C. find the initial date of publication.
- D. survey people.

There are no passages to read and analyze on the English Language Arts section of the CST; content taught in middle school ELA classrooms is not tested. Teaching English language arts is the focus of the ELA section of the CST, but that is not the case in the math section. The math section, however, does include questions like those taught and tested in grade eight.

Consider the math questions given in Figure 2 with those in Figure 4 found below, both require an understanding of similar triangles and/or proportion.

**Figure 2**

*Sample Questions That are Comparable to the Preparation Materials for the Math Section of the Early Childhood Multi-Subject CST*

- (1.) There are two similar triangles. The smaller one measures 7, 10 and 12. The smallest side of the larger triangle is 21. What is the measure of the other two sides of the larger triangle?
- E. 30, 36
  - F. 24, 26
  - G. 20, 24
  - H. 40, 48

- (2.) Which number sentence does not equal -12
- E.  $-3(-4)$
  - F.  $-14 + 2$
  - G.  $-10 + -2$
  - H.  $-24/2$

**Figure 4**

*Questions Comparable to the Eighth Grade Math Exam Released Questions*

- (1.) Erin walks to school each day. The distance is 4 miles, and it takes her 45 minutes. Approximately how far has she walked in 15 minutes?
- A. 1.34 miles
  - B. 2.5 miles
  - C. 3.0 miles
  - D. .676 miles

While the math section of the CST seems to test math content, the English language arts section tests pedagogical content knowledge aligned with teaching in the early grades. These tests are not congruent. As we strive to improve early childhood education shouldn't we want educators who possess pedagogical content knowledge for math? "Teaching is not merely about doing math oneself, but about helping students learn to do it" (Thames and Ball, 2010 p.228). The math understanding needed is the kind that can be used to help others learn mathematics. Perhaps, because we are assessing teacher candidates on math content instead of the math knowledge needed to help young children learn math, teacher candidates are not performing well on the math section of the CST. In the next section, I will discuss the passing rates for early childhood educators.

### **Passing Rates for Early Childhood Educators**

In data from SUNY New Paltz for the first cohort of candidates taking the Birth-Grade 2 multi-subject exam, 74% passed the ELA section and 57% passed the math section (src: [newpaltz.edu/schoolofed/nystce.html](http://newpaltz.edu/schoolofed/nystce.html)). Information on testing provided by the New York State Education Department about test development through the *Freedom Of Information Act* showed even worse passing rates in the development of the test, 47%. More recent data can be found on [edreports.nesinc.com](http://edreports.nesinc.com) but it cannot be shared in this publication. Are we testing the pedagogical content knowledge gained in teacher preparation courses and field experiences at the early childhood level or are we testing something else?

One problem with this exam is the confusion regarding what it is intended to test. The ELA section clearly addresses teaching ELA and the math section clearly addresses a teacher candidate's math knowledge. If we want early childhood educators to possess a wide range of

content knowledge more germane to an advanced study in content than the math exam is appropriate, and the ELA exam is not. If we want early childhood educators to demonstrate the PCK needed to teach young children, then the English language arts section is appropriate and the math section is not.

### **CST Development**

I attempted to find information about test development, reliability, and validity of the CST for Early Childhood Educators, Birth-Grade 2. There was nothing readily available and I had to request access through the Freedom of Information Act. My request was fulfilled, and documents were sent from the New York State Education Department.

The first interesting finding was that the frameworks were developed with alignments between the test and New York State Teaching Standards. The document used the early childhood multi-subject as an example and furnished the two descriptions illustrated in Figure 5. With a thorough reading you can see that the two tests are quite different.

### **Figure 5**

*Excerpt from Multi-Subject Teachers of Early Childhood (Birth-Grade 2) Test Framework*

The New York State Birth–Grade 2 Multi-Subject educator has a high degree of proficiency in the content knowledge and professional skills required for planning and implementing standards-based literacy and English language arts instruction and assessment that effectively promote student achievement of the Prekindergarten–Grade 2 standards in the New York State P–12 Common Core Learning Standards for English Language Arts & Literacy (NYCCLS). The teacher skillfully applies knowledge of language and literacy development and knowledge of developmentally appropriate, effective materials, instruction, and formal and informal assessment in all aspects of literacy and English language arts to meet the literacy-learning needs of children from birth through grade 2 across the content areas.

The New York State Birth–Grade 2 Multi-Subject educator has the mathematics knowledge and skills necessary to teach effectively in New York State public schools. The teacher understands mathematics as a coherent set of fundamental principles that is built on precise definitions and logical reasoning. The teacher understands and uses mathematical language. The teacher has a deep understanding of the New York State P–12 Common Core Learning Standards for Mathematics (NYCCLS) and effectively connects the standards for mathematical practice with the standards for mathematical content to demonstrate a high level of mathematical proficiency and to provide highly effective mathematics instruction.

The ELA uses vocabulary such as: “the teacher skillfully applies” and “knowledge of language and literacy development.” While the math section says, “the teacher has and the teacher understands” and “demonstrates a high level of proficiency.” Again, the ELA section is about teaching and the math section is about knowing, as if knowing math demonstrates that you can teach it to young children. Mathematics and teacher education research have demonstrated for decades that knowing math does not mean that you can teach it to others; teaching math is complex.

When I searched for the reviewers of this framework the documents showed a member of the New York State Education Department Early Learning Team and an influential member of a not-for-profit organization focused on the common core. There were no members of the New York State Association for the Education of Young Children, no members of the Association of Mathematics Teachers of New York State and no early childhood educators.

The documents provided by the New York State Education Department included a discussion of the relevancy of the CST because it is aligned to the New York State Teaching standards (NYSTS), the New York State Common Core Learning Standards (NYCCLS) as well as the Interstate Teacher Assessment and Support Consortium Model Core Teaching Standards (InTASC). When reviewing the content correlation tables for the multi-subject CST for early childhood, the ELA section includes the NYCCLS and NYSTS as expected, but it also includes references to standards from the International Reading Association (IRA), the National Council of Teachers of English (NCTE) and the International Dyslexia Association (IDA). It shows a thorough investigation into relevant standards for teaching and learning in English Language Arts.

The math relevancy table shows NYCCLS for each area of the framework except the essay or constructed response portion, which indicates New York State Teaching Standards. There are no references to standards from the National Council of Teachers of Mathematics or any other association focused on the teaching and learning of mathematics. A revision to the CST was completed in 2023 and the revised version will be used. This updated version removes some mathematics content but does not change the frameworks. The test is still about knowing math, not teaching math to young children. Again, the professional organizations devoted to mathematics teaching and learning, and the education of young children were left out. Standards from the National Council of Teachers of Mathematics are not cited in the information about the design of the newest version of the test. This further illustrates that the math section of the early childhood CST is about knowing math, not about teaching it to young children.

### **Mathematics Instruction to Improve Mathematics Learning**

No one would argue that we want our teachers to be knowledgeable in both ELA and Math, but it seems that we are testing math knowledge that may not be appropriate for early childhood educators and leaving pedagogical math knowledge necessary for the successful teaching of math to young children out of the test. The studies on the importance of pedagogical content knowledge are numerous and robust. Stemming back to Skemp (1978), the importance of understanding relationally not just instrumentally is cited. The math knowledge we want for our children is about understanding concepts, not just applying rules, and getting right answers. Studying pedagogical content knowledge moves the teacher candidate from thinking that math is about getting the right answer and instead helps them focus on how to solve problems, when to

apply strategies, and why certain methods work. Candidates who possess this knowledge are more likely to teach mathematics in a way that also fosters problem-solving and critical thinking.

The improvement of mathematics teaching and learning is a priority in many schools and communities. The performance of the United States on international assessments in mathematics has not been stellar and never has been. Recommendations to improve teaching and learning point to instructional strategies that focus on: (1.) making sense of mathematical ideas, (2.) providing meaningful experiences for students, (3.) communicating in mathematics, and (4.) developing thinking and reasoning. The National Council of Teachers of Mathematics (NCTM), in the publication *Principles to Actions* (2014), writes that assessments for students have emphasized skills and fact recall over problem-solving and reasoning and that this has left many students especially those from groups that are often underrepresented in mathematics fields with low levels of learning. We need to change the teaching of mathematics.

The NCTM suggests the following teaching practices as essential: (1.) establishing clear goals, (2.) implementing tasks that promote reasoning and problem-solving, (3.) using and connecting mathematical representations, (4.) facilitating discourse, (5.) posing questions, (6.) building fluency from conceptual understanding, (8.) supporting productive struggle, and (9.) using evidence of student thinking for assessment. Teacher preparation programs have answered this call and implemented such practices in both math classes for early childhood educators and in pedagogy classes for early childhood mathematics. The NCTM goes on to say that policy makers must align accountability measures for teachers to these practices. Unfortunately, New York State is not aligned with these recommendations.

Early childhood teacher candidates are assessed on math knowledge that is skill and fact based, reasoning and problem solving are limited, and little attention is given to PCK where the understanding of the recommendations to improve mathematics learning could be assessed. The test construction team has focused on testing minutiae, not related to the teaching, and learning of young children. What New York State needs is a test that measures a teacher candidate's ability to: (1.) build content around big ideas in mathematics like counting, measuring, and patterning; (2.) mathematize the child's environment, (3.) use stories and literature to develop number sense, and (4.) motivate and engage all young children in the learning of mathematics. There are areas of mathematics content like subitizing, pattern structure, and decomposition and how to teach and assess student learning on this content that can and should be tested.

Thames and Ball (2010) suggest test items for teacher education that focus on the knowledge needed for teaching young children; such items can be written. Howell and Phelps (2016) describe items for teacher education that first require the candidates to analyze student work, thus illustrating their content knowledge and then answering a question about next steps. They discuss the importance of context to content, therefore asking candidates to not just do math, but to find and analyze student errors to anticipate and then remedy misunderstandings. While the essay section of the content specialty test does this, it is not the majority of the test.

The educative teacher performance assessment (edTPA) developed at Stanford with attention to reliability and validity also does this, yet it was scrapped as a certification exam in New York with the expectations of assessing performance given back to the teacher preparation programs. The edTPA is based on years of research on teaching and was reviewed by hundreds of education professionals including those from professional organizations such as the National



Council of Teachers of Mathematics (edTPA.com) Perhaps the CST should also be scrapped and the burden of assessing teacher candidates in mathematics teaching for early childhood left to the teacher preparation programs too. Doing so would allow testing in a way that reflects the PCK we want early childhood educators to possess to teach mathematics in the way we want children to learn it.

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