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Roaring Twenties: What did it take to be a Math Teacher?

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Abstract

Pursuing a teaching career in 1920 took more than a simple test to assess your knowledge in just one subject. Interested candidates could choose one of two paths, enroll in a teacher program through a university or normal school or take the state created certification tests. Those who chose to take the tests had to take and pass 12 individual tests in order to apply for a 4 or 6 year certificate. The authors examined and compiled a listing of the State created certification test questions for arithmetic, algebra, and solid geometry from records discovered at George Memorial Library, a Texas Regional Historical Resource Depository, in Richmond, TX. Four arithmetic administrations were transcribed and categorized into mathematics topics. Of these four administrations, two of them, August 20, 1920 and September 3, 1920, were cross-referenced to nine test taker responses. During the August 20, 1920 administration of the test, authors found five test takers' responses that correlated to the test questions. They also found four test takers' responses that correlated to the September 3, 1920 administration. The authors analyzed the methods the test takers used when solving the questions on these two administrations. Between the test takers, the most common mistakes were simple computation errors, which jeopardized the test takers' final score. The results in this study are important because each of the questions give you a glimpse into what it was like to live in the 1920s. The context of the questions also shares the values and goal of education during this time, which was to create a well-rounded individual who would be successful in society.

Keywords: Arithmetic, Texas State Certification, 1920s, Teacher Certification, Mathematics History

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To be a Math Teacher: Texas Certification Tests & Teacher Answers

There are many educational misconceptions about what the beginning of the 20th century was like for teachers and teaching. Despite popular belief that one could teach without subject area mastery, often times, more content knowledge was required than some would think. People seeking to become certified teachers were required to pass numerous subject area qualifying tests that some might construe as being extremely rigorous by today's standards (Burlbaw, L. M., 2005; Burlbaw, L. M., Kelly, L. J., and Weber, N. D., 2013; Burlbaw, L. M., Kelly, L. J., Weber, N. D, and Van Zandt, J., 2012.; Bi, Y. and Burlbaw, L. M., 2011, 2102; Capraro, R. M. , Burlbaw, L. M., Zientek, L., 2009; Harper, D., Kelly, L. and Burlbaw, L. M., 2011; Sonnenburg, S., and Burlbaw, L. M., 2014; Van Zandt, J., Bi, Y., and Burlbaw, L. M.., 2012). In Texas, the minimum number of tests a candidate had to pass for a Second Grade Certificate, the lowest level certificate, was twelve tests. Today these tests are known as the core subjects, such as mathematics, language arts, science, and history.

Using records stored at the George Memorial Library, the authors examined and compiled a listing of the state created certification test questions for arithmetic, algebra, and solid geometry to determine what was considered necessary knowledge and skills to teach elementary mathematics. Other records at the library included about 40 test takers' written answers to questions. Unfortunately, two conditions complicated the analysis of the answers. First, state listings of questions were not available for every test administration. Second, the test takers' written work did not include the question. Therefore both questions and answers were classified according to conceptual knowledge required to answer the question or being demonstrated by the answer. Data reduction was used to draw conclusions about the test takers' content knowledge.

The purpose for this research is two-fold. First, was to describe the certification process for the Second Grade Certificate teachers could earn in Texas. Second, was to analyze the arithmetic questions and answers that were found in the archives at the George Memorial Library.

Guidelines for the certification and hiring of teachers to teach in common and independent (city) schools was established by the Texas State Superintendent of Public Instruction in the early part of the 20th century. Multiple methods were outlined, ranging from degrees at state institutions of higher education (e.g., The University of Texas at Austin) through

Normal Schools (e.g., Sam Houston Normal Institute) and county superintendent administered tests. The county tests were administered on a regular basis (i.e., "the first Friday and Saturday following in the months of June, July, August, September and December of each year") and "board of examiners shall use the questions prescribed by the State Department of Education, and shall conduct the examination in accordance with the rules and regulations prescribed by the State Department of Education and the county superintendent of public instruction" (State Department of Education, 1915, p.3).

Brazoria County, located in southeast Texas, was a rural area with a population of 14,861 in 1910 falling to 13,299 in 1920, the year this study focuses on. In 1920, there were 21 White common school districts and 17 Black common school districts in Brazoria County. There were also nine White and eight Black independent (city) districts. While most of the independent districts had both elementary (grades 1-7) and high schools (grades 8-11), the common school districts usually only offered elementary education.

The teachers teaching in the various schools held a variety of certifications, ranging from Second Grade (4 or 6 year certificate for elementary schools) to State Permanent (certifying a teacher to teach at all grade levels for life). Table 1: Certificates for Teachers, shows the types of certificates that were available. The two routes to certification were through county superintendent administered tests and post-secondary education, with the type of certificate depending on the degree and number of courses taken at the Normal school. The grade designations, First or Second, did not indicate school level but quality of certificate. First Grade Certificate holders could teach in any Texas public school, while Second Grade Certificate holders could only teach in elementary grades in Texas public schools. Cities could also offer *City Certificates*, where the requirements could be equal to or higher than required by the state, and had to be valid for the time designated by the State. All candidates for certification were required to be at least 16 years of age.

Table 1. Certificates for Teachers

Temporary		Permanent - lifetime	
State	City	State	City (required 3 years of experience in Texas prior to issuance)
Second grade (4 years)	Second grade (4 years)	State Permanent Certificate	Second grade
First grade (4 years)	First grade (4 years)	State Permanent Primary Certificate	First grade
	High School (6 years)		High School

The teachers whose test answers were found at the George Memorial Library took the test for a temporary Second Grade Certificate. This certificate required test takers to pass 12 tests. The following nine tests were required of all test takers applying for a second grade certificate: Spelling, Reading, Writing, Arithmetic, English Grammar, Texas History, United States History, Elementary Physiology and Hygiene, and School Management and Methods of Teaching. Test takers then had the option to take any three of the following: Elementary Agriculture, Elementary Composition, Drawing, Descriptive Geography and Music. Teachers who passed all 12 of these tests with a grade of at least 50 in each subject and an overall average of at least 75 were awarded a four-year certificate. If every test was passed with a score of at least 50 and the overall average was 85, the teacher was awarded a six-year certificate. Certificates were valid until the fourth or sixth anniversary of August 31st from the year the test was taken (State Dept of Education, 1915).

Arithmetic Tests

Arithmetic is an important concept for mathematics instruction. Young (1914) gave several reasons for the purpose of teaching arithmetic; teaching students to think mathematically, make them interested in the world around them, compute accurately, apply arithmetic to real world applications, and give foundation for higher mathematics. Young (1914) continued that students needed to know arithmetic to be able to: count and be knowledgeable of numbers up to the billions, add, subtract, and multiply integers, and know just a little bit of division, to be successful in daily life. Further instruction of arithmetic should focus on converting numbers from pounds to ounces, simple geometry skills, and enough about percentages to calculate discounts and interest (Young, 1914). Young (1914) and later Stone (1925) grouped arithmetic into several categories. Using their examples, the test questions were classified into the following six major categories: four fundamental operations, fractions and decimal fractions, proportions, percentages, square and cube roots, and measurement.

Teachers written answers to arithmetic tests are available from numerous administrations, as are copies of the exam provided by the State Superintendent of Public Instruction. The required Arithmetic test for the Second Grade Certificate was administered Friday morning; in this case, August 20, 1920; September 3, 1920; June 17, 1921, and December 16, 1921. However, the authors were able to match only questions and answers from two administrations (August 20, 1920 and September 3, 1920); these pairs were transcribed and coded for this study.

Types of Questions

Four fundamental operations. The four fundamental operations include addition, subtraction, multiplication, and division. Young (1914) encouraged the use of Grubes' plan, meaning that the operations be taught in succession until students become fluent in all four operations. Once they were successful with the operative combinations for each number, they could move into larger numbers. For instance, he believed students should work with numbers 1-5, 1-10, 1-20, 1-100, and then 1-1,000 utilizing all four operations (Young, 1914). However, Stone (1925) suggested teaching primary facts one operation at a time instead of teaching all the operations at once. He believed this order would be much more efficient for students. Most schools now teach the way Stone (1925) suggests and teach the operations in succession, they first learn to add and subtract fluently, before multiplication and division are introduced. Regardless of the method, both Young (1914) and Stone (1925) agree students must be drilled to learn the facts so they can commit them to memory and recognize the converse forms (1+3 or 3+1; 5-3=2 or 5-2=3; 15÷3=5 or 5 × 3 = 15, etc.) of the operations. Very few of the questions on the arithmetic tests focused solely on the four operations, these skills were integrated into the other categories (See Table 2).

Table 2. Types of Questions on the Tests (number of items on each test in each category)

Type of Question	August 20, 1920	September 3, 1920	June 17, 1921	December 16, 1921
Four Fundamental Operations	2	0	1	1
Fractions and Decimal Fractions	4	1	0	1
Proportions	1	3	2	1
Percentage	3	5	3	3
Square Root & Cube Root	0	1	0	0
Measurement	2	2	3	3

Fractions and decimal fractions. Fractions are more complex than whole numbers, but can be easily taught or explained with concrete manipulatives. First, lessons on fractions should include pictures and the names of the fractional units, so that students become familiar with the correct terminology (Stone, 1925). Once introduced, they should be applied to real world scenarios, for instance "If milk is 10 cents per quart, how much is a pint worth?" (Stone, 1925, p. 96). Young (1914) argued that fractions and decimal fractions be taught alongside one another, because decimal fractions were just another way of writing a fraction. Fractions and decimal fractions were heavily tested on August 20, 1920 (See Table 2), but decreased on subsequent sessions because they tested the fraction concepts through the proportions and percentage questions.

Proportions. Proportions are very similar to fractions and Young (1914) believed there was no need to separate the two categories, because students would just apply their knowledge of fraction proportions. He also said that simple proportions were all that was needed for arithmetic, for example "if cloth costs 75 cents per yard, 5 yards cost 5 times 75 cents" (Young, 1914, p. 239). These are the types of scenarios students would face in the real world. Proportion questions were common on the arithmetic test because it allowed test takers to show they could apply fractions to real world settings (See Table 2).

Percentages. Percentages are just another application for fractions and should not be taught independently or seen as a new concept (Stone, 1925). In order to see the new term, per cent, students were asked, “If a man in business makes $15 out of every $100 he receives for goods, what part of his receipts is profit?” (Stone, 1925, p. 124). The teacher can lead students to say the man would make 15 per cent, “per (out of) and centum (a hundred)” (Stone, 1925, p. 124). Percentages are seen in several social and business transactions, so this concept is a major topic that is covered in arithmetic. Questions stem from commissions, discounts, profits and loss, interest, insurance, taxes, banking, and stocks. All of these were important to everyday life at the time these teachers were teaching, so it was crucial students could solve problems involving percentages. In Table 2, you can see this type of question was the most seen for every test session.

Square and cube roots. Students can understand square roots and cube roots of small numbers by creating or seeing if they are perfect squares or cubes (Young, 1914).Young (1914) observed the need for extracting the cube root was slowly disappearing from arithmetic instruction, but extracting the square root was still taught because of its connections to geometry. However, this topic was seen as more of a high school topic, which is probably why it was not tested in several of the arithmetic sessions of the Second Grade certificate (See Table 2).

Measurement. Measurement is a broad topic in arithmetic, it includes concepts such as: unit conversions, the metric system, area, and volume (Stone, 1925). Each of these concepts rely on the previously discussed categories such as the four fundamental operations, fractions, and proportions. Since measurement can cover many concepts it was tested consistently in all four arithmetic sessions. It was probably tested consistently because it was practical and educated students on concepts they would be faced with daily throughout their lives.

Table 3 shows examples of test questions by each of the different categories. When taking this test, test takers had to be aware of real world situations because most of the questions were placed in real world scenarios. Not many questions focused on only the four fundamental operations, some questions could have been dual coded into the four fundamental operations category and measurement, because test takers were asked to use the four operations in real world settings.

Table 3. Examples of Test Questions by Category

Four Fundamental Operations	When a sum of money is divided equally among 7 persons, each received $16.80. How much would each received if the same sum were divided equally among 8 persons? (August 20, 1920) Solve $\frac{16\,3/4 + 2\,1/3 \times 4}{9\,6/7 - 4\,1/5 \div 2}$(December 16, 1921)
Fractions and Decimal Fractions	(a) Change the following to decimals of not more than three places: 13/16, 2 11/25, 4 9/75. (b) State the common fraction equivalents of .83 ⅓, .41 ⅔, .62 ½. (August 20, 1920) The California orange box is sometimes 26 ½ in. by 11 ¼ in. by 11 ¼ in., and sometimes 22 in. by 7 ¾ in. by 17 ½ in. Which holds the more, and how many cubic inches more? (September 3, 1920) A man who owned some shares of stock in a mill sold ⅓ of his shares to A, ⅕ to B, and ⅙ to C. He then had 90 shares left. How many shared had he first? (December 16, 1921)
Proportions	A train leaves a city at 10:45 a.m. and reaches another city 127 ½ mi. distant at 5 min. past 2 p.m. Allowing 20 min. for stops, what is the rate per hr.? (August 20,1920) Two men start from points 33 mi. apart and walk toward each other, the first at the rate of 4½ mi. per hr., and the other second at the rate of 3¾ mi. per hour. How far from where the second man started will they meet? (June 17, 1921) A man owns a house valued at $12,800. He rents it for $768, paying taxes at the rate of 2 mills, $24.20 for insurance, and $144 for other expenses. Find the net per cent [sic] of income on the value of the property. (December 16, 1921)
Percentage	By buying at a bargain sale an $18 suit at 15% off, three $1.50 shirts at 10% off, a dozen 25-cent handkerchiefs at 16 ⅔% off, a pair of $4.75 shoes at 25% off, and a hat and some ties amounting to $5.35 at 20% off, how much does a man save in all? (August20, 1920) A grocer buys matches at 48 cents a dozen boxes and sells them at 54 cents. What is his percent of profit? (September 3, 1920) A house valued at $4400 is insured for 80% of its value, the premium being $44. What is the rate of insurance? (June 17, 1921) A draft dated Aug. 8 at 30 days sight, for $975, is accepted on Aug. 10, and is discounted on Aug. 16 at 6%. What are the proceeds? (December 16, 1921)

Square Root & Cube Root	Extract the square root of 110.25. (The work must be written in full.) (September 3, 1920)
Measurement	A cubic foot of water weighs 62 ½ lbs. From a tank containing 16 cu. ft. there is drawn off an amount of water that weighs 125 lbs. What per cent of the water is drawn off? (August 20,1920) How many gallons (231 cu. in.) in a cylindrical tank 32 ft. high and 30 ft. in diameter? (September 3, 1920) Find in inches the depth of a cylindrical tank 5 ft. in diameter that has the same capacity as a rectangular cistern 8 ft. square and 6 ft deep. (June 17, 1921) What will the lumber cost for a set of steps if lumber is selling at $27 per M and if 12 boxing planks 1 inch by 12 inches by 12 feet and 6 boards 2 inches by 8 inches by 5 feet are required? (December 16, 1921)

Uncommon Words

Teachers advocate for the use of content specific vocabulary in the classrooms, so that students can be successful at solving mathematics word problems (Barroso, Bicer, Capraro, Capraro, R. M. , Foran Grant, Lincoln, Nite, Oner, & Rice, 2017; Capraro, R. M. , Barroso, Nite, Rice, Lincoln, Young, & Young, 2017) . True today, this was also the case in the 1920s; teachers who were testing needed to be familiar with vocabulary and real world applications of their mathematical skills. In several of the questions, there were some vocabulary words that are uncommon in the present day, but would have been common for the teachers in the 1920s.

First, in one question it asks about cogwheels and cogs: “Two cogwheels are so geared that for every revolution of the larger the other revolved 12 times. The larger wheel has 204 cogs. How many cogs has the smaller?” (June 17, 1921 test, question 7). Even though, cogwheel may not be a specific mathematical content vocabulary word, test takers still needed to understand what a cogwheel and a cog were in order to be successful on this question. These terms are no longer common when discussing gears and revolutions.

Second, although this question does not have an uncommon word, it had an uncommon abbreviation: “One man can do a piece of work in 10 da., and another can do the same work in 9 da. If the wages of the first are $3.6 a da., what should be the wages of the second?” (September 3, 1920 test, question 10). At first glance, this seems like a fairly easy question, but one might wonder what da. is abbreviated for, and here da. is abbreviated for days. Now, the word days would not be abbreviated, but in 1920 this was an acceptable abbreviation.

A third example of an uncommon word occurred in a question about owning a house and paying taxes: “A man owns a house valued at $12,800. He rents it for $768, paying taxes at the rate of 2 mills, $24.20 for insurance, and $144 for other expenses. Find the net per cent of income on the value of the property” (December 2, 1921 test, question 6). This question in itself is very different, but the part that is mainly uncommon is paying taxes at the rate of 2 *mills*. The value of a mill is 1/1000 of a dollar or 1/10th of a cent. A tax at rate of 2 mills customarily, when applied to property taxes is a rate per $1, indicates a tax of 2/10th of a cent per dollar of the house value.

In this question, you can also see that they wrote the word percent with a space in the middle, percent was spelled this way because it was “seen as a special name for a special fraction, one whose unit is hundredths” (Stone, 1925, p. 123).

A fourth example of an uncommon word was seen in the following question, with the word cord: “A farmer has 75 trees on an acre of woodland, of which he decided to cut 60%. If wood is worth $5.75 a cord and he can cut 3 cords from 5 trees, how much will he receive for the wood?” (August 20, 1920 test, question 9). The word cord is not used generally when discussing cutting trees and to answer the question you do not necessarily need to know what a cord is, because you can answer it just using the context clues. A cord is an official measurement of firewood (a stack 4 feet wide, 4 feet high and 8 feet long), and this was probably a familiar term used in the 1920s. Today, most people, rather than referring to the amount of wood that could be cut, use the term in relation to firewood, buying a whole cord or a ½ cord, which is equal to a rick.

The final example of an uncommon word was the word draft, and draft is not uncommon currently, but the way it was used in the following question, make its uncommon. “A draft dated Aug. 8 at 30 days sight, for $975, is accepted on Aug. 10, and is discounted on Aug. 16 at 6%. What are the proceeds?” (December 2, 1921 test, question 9). From this question, all of these words are common today, but taken in this context, it is very hard to understand what is being asked. However, this question could be answered now without knowing these words if the test taker was knowledgeable in their mathematical abilities.

All of these questions pertained to everyday life in the 1920s, they were practical and relevant during this time period. Many of the uncommon words are still around today, but are not used by the general public; most of them are specific to a trade or job. People working in those real world scenarios currently would recognize these words, but the average person would not. These questions imply schools and teachers were providing a relevant education that allowed students to use their math skills outside of school. The types of scenarios used in the questions allude to the purpose of education in the 1920s, to educate a well-rounded individual who would contribute to society. Looking back at these questions, even though they seem difficult or irrelevant, gives one a glimpse into the past and what was valued as important in education. Reviewing these questions also made the authors wonder, how important is the actual vocabulary, if one can use context clues to figure it out and still answer the question. These examples shine a new light on the importance of reading and learning skills needed to decipher unknown words.

Coordination of Math Tests with teacher responses

The authors were able to match a total of nine test taker responses with the August and September test administrations from the archives. No responses were found for the June and December test administrations in the archives. For the August 20, 1920 arithmetic test, there were five test taker responses found. These test takers were applying for their Second Grade certificate and their ages ranged from 18-30 (See Table 4). Only one of the test takers was colored, married, and had teaching experience. On the September 3,1920 arithmetic test, we were able to match four test responses. The four of these test takers were applying for their Second Grade certificate, were not married, had no teaching experience, and their ages ranged from 18-25 (See Table 5).

Table 4. Demographics of Test Takers Examined for August 20, 1920 Test

Name	Type of Certificate	Age	Sex	Color	Years of Experience in Texas	Married	Post Office
A. L. Carter	2nd	30	F	Negro	8	Yes	West Columbia, TX
M. R. Johnston	2nd	25	F	White	None	No	Pearland, TX
M. Burridge	2nd	18	F	White		No	Angleton, TX
V. L. Hays	2nd	18	F	White		No	Velasco, TX
L. R. Harris	2nd	18	F	White	None	No	Angleton, TX

Table 5. Demographics of Test Takers Examined for September 3, 1920 Test

Name	Type of Certificate	Age	Sex	Color	Years of Experience in Texas	Married	Post Office
E. Erskine	2nd	19	M	White	None	No	Liverpool, TX
V. L. Hays	2nd	18	F	White		No	Velasco, TX
M. R. Johnston	2nd	25	F	White	None	No	Pearland, TX
L. B. Burridge	2nd	20	F	White	None	No	Angleton, TX

August 20, 1920 Analysis of Written Answers

On the August 20, 1920 test (See Figure 1), there were a total of 12 questions, of these the test takers were asked to choose eight to attempt. The authors examined the test takers' responses to learn which questions they decided to answer and then analyzed their responses and methods. Hays only answered 7 questions for this test administration.

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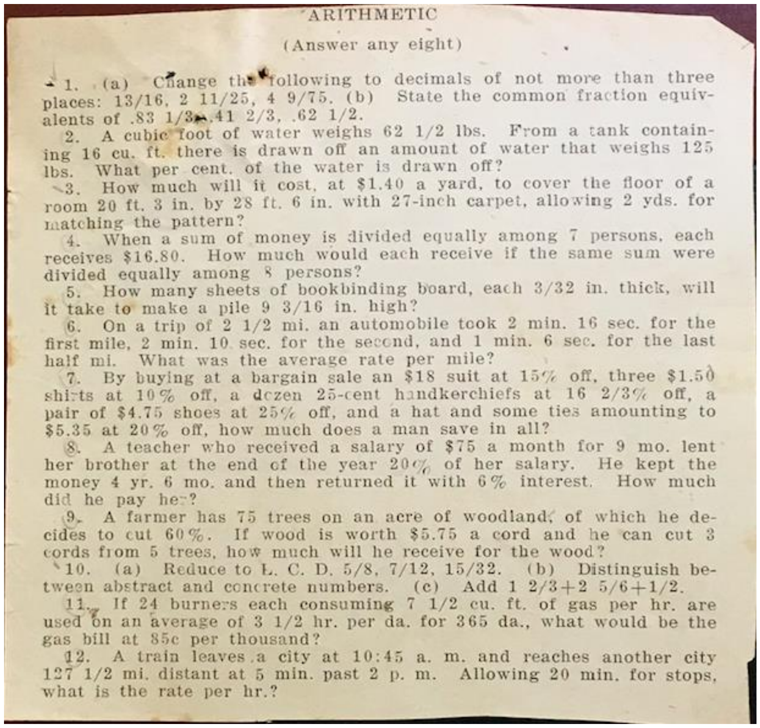
ARITHMETIC

(Answer any eight)

1. (a) Change the following to decimals of not more than three places: 13/16, 2 11/25, 4 9/75. (b) State the common fraction equivalents of .83 1/3, .41 2/3, .62 1/2.

2. A cubic foot of water weighs 62 1/2 lbs. From a tank containing 16 cu. ft. there is drawn off an amount of water that weighs 125 lbs. What per cent. of the water is drawn off?

3. How much will it cost, at $1.40 a yard, to cover the floor of a room 20 ft. 3 in. by 28 ft. 6 in. with 27-inch carpet, allowing 2 yds. for matching the pattern?

4. When a sum of money is divided equally among 7 persons, each receives $16.80. How much would each receive if the same sum were divided equally among 8 persons?

5. How many sheets of bookbinding board, each 3/32 in. thick, will it take to make a pile 9 3/16 in. high?

6. On a trip of 2 1/2 mi. an automobile took 2 min. 16 sec. for the first mile, 2 min. 10 sec. for the second, and 1 min. 6 sec. for the last half mi. What was the average rate per mile?

7. By buying at a bargain sale an $18 suit at 15% off, three $1.50 shirts at 10% off, a dozen 25-cent handkerchiefs at 16 2/3% off, a pair of $4.75 shoes at 25% off, and a hat and some ties amounting to $5.35 at 20% off, how much does a man save in all?

8. A teacher who received a salary of $75 a month for 9 mo. lent her brother at the end of the year 20% of her salary. He kept the money 4 yr. 6 mo. and then returned it with 6% interest. How much did he pay her?

9. A farmer has 75 trees on an acre of woodland, of which he decides to cut 60%. If wood is worth $5.75 a cord and he can cut 3 cords from 5 trees, how much will he receive for the wood?

10. (a) Reduce to L. C. D. 5/8, 7/12, 15/32. (b) Distinguish between abstract and concrete numbers. (c) Add 1 2/3+2 5/6+1/2.

11. If 24 burners each consuming 7 1/2 cu. ft. of gas per hr. are used on an average of 3 1/2 hr. per da. for 365 da., what would be the gas bill at 85c per thousand?

12. A train leaves a city at 10:45 a. m. and reaches another city 127 1/2 mi. distant at 5 min. past 2 p. m. Allowing 20 min. for stops, what is the rate per hr.?

Figure 1. August 20, 1920 Arithmetic Test

Out of the twelve questions available to the test takers, three were attempted by all five test takers - questions 4, 8 and 9 (Table 6). The authors examined each of the three questions to learn how the test takers solved the problems

Table 6. Scores on August 20, 1920 Test

Name	1	2	3	4	5	6	7	8	9	10	11	12	Total
A.L. Carter	8	12.5	8	7	12.5			12.5	12.5			12.5	82
M. R. Johnston			12.5	12.5	2	12.5	12.5	8	3			12.5	51.5
M. Burridge			3	12.5		8	8	12.5	3			3	66
L. Harris		12.5		12.5	7	12.5	8	12.5	8		9	12.5	44
V. L. Hays		12.5		12.5	12.5	3	4	8	3				55.5

The first problem solved by all test takers was question four (see Figure 1). Four of the five test takers made a perfect score. The four who received full credit multiplied $16.80 by

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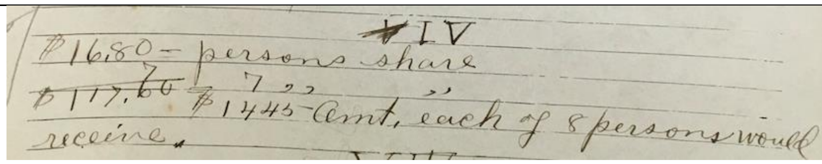
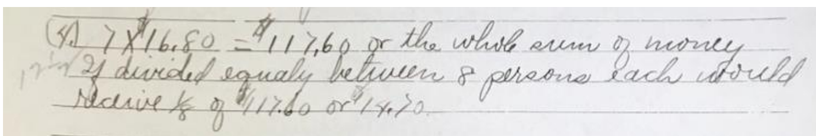
seven and found the sum of money, then divided the sum of money by eight to determine what each person will receive (See Figure 2). The method the test taker took in 1920 is similar to how it would be solved today. The slight difference is the problem can be set up as fraction proportions and solved by cross-multiplying.

Q4. When a sum of money is divided equally among 7 persons, each received $16.80. How much would each received if the same sum were divided equally among 8 persons?

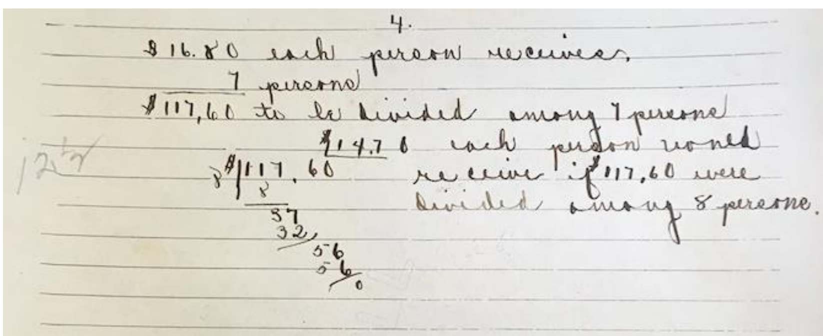
A. L. Carter


IV
$16.80 – persons share
$117.60 7 "
$1445 – Amt. each of 8 persons would receive.

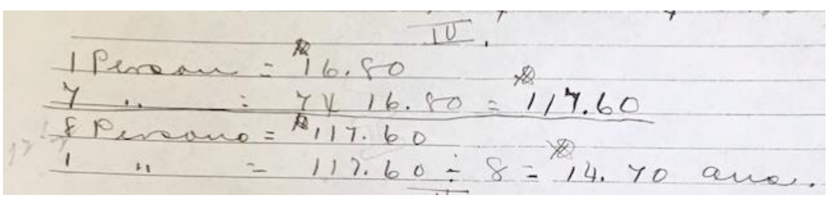
M. R. Johnston


(4) 7 X $16.80 = $117.60 or the whole sum of money
If divided equaly between 8 persons each would receive 1/8 of $117.60 or $14.70.

M. Burridge


4.
$16.80 each person receives.
7 persons
$117.60 to be divided among 7 persons
$14.70 each person would receive if $117.60 were divided among 8 persons.
8)$117.60
8
37
32
56
56
0

L. Harris


IV.
1 Person = $16.80
7 " = 7 X 16.80 = $117.60
8 Persons = $117.60
1 " = 117.60 ÷ 8 = $14.70 ans.

V. L. Hays

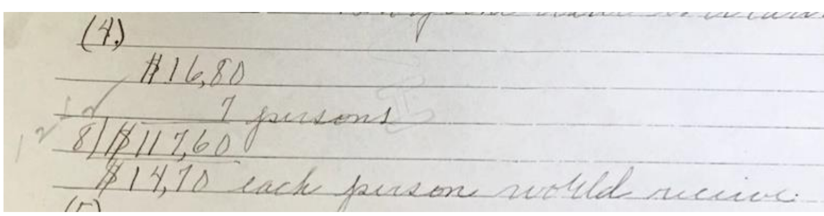

(4)
$16.80
7 persons
8)$117.60
$14.70 each person would receive

Figure 2. August 20, 1920 - Question 4 Test Taker Responses.

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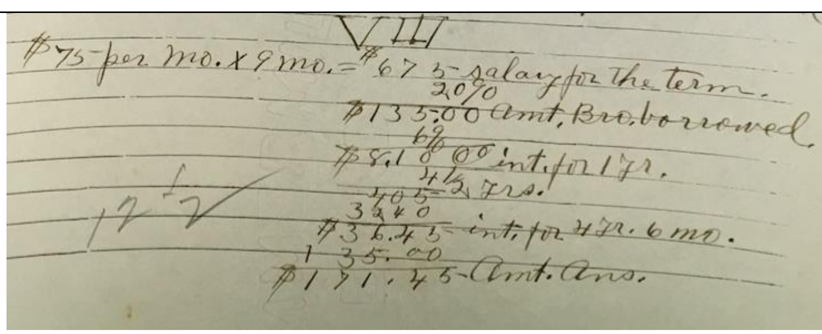
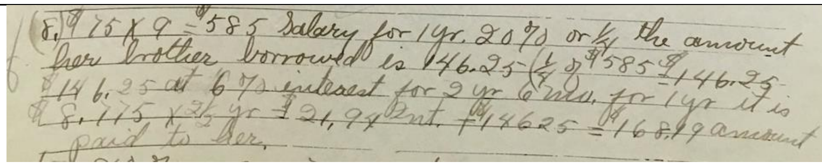
On question eight (Figure 3), two of the five test takers did not make a perfect score. Hays and M. Burridge both received only eight points. But, when analyzing their work (see Figure 3), they received partial credit for different reasons. Hays completed the problem correctly by finding the total teacher's salary, the amount the brother borrowed, the interest on the amount borrowed, but did not find the total amount the brother owed after the 4 ½ years. She missed the last step of the problem, which was adding the amount borrowed and the interest on the amount borrowed; because of this she received partial credit. Johnston's response began with an incorrect computation when solving for the total teacher salary. After finding the incorrect salary amount, she then attempted to find 20% of the salary to determine the amount borrowed, and stated that 20% was the same as ¼ of the amount, however, this was also incorrect, it is actually ⅕ of the amount. She continued following the correct procedure to solve the problem, but also instead of finding the interest earned for 4 ½ years, she found the interest for 2 ½ years. Johnston followed the correct process to solve the question, but all of these computation errors and careless mistakes resulted in the wrong amount the teacher's brother owed. Considering all of these mistakes, it is surprising that Johnston and Hays received the same score for this question. Carter, M. Burridge, and Harris received a perfect score for this question, by correctly computing the teachers salary, the amount borrowed, the interest on the amount borrowed, and then finally finding the total amount owed.

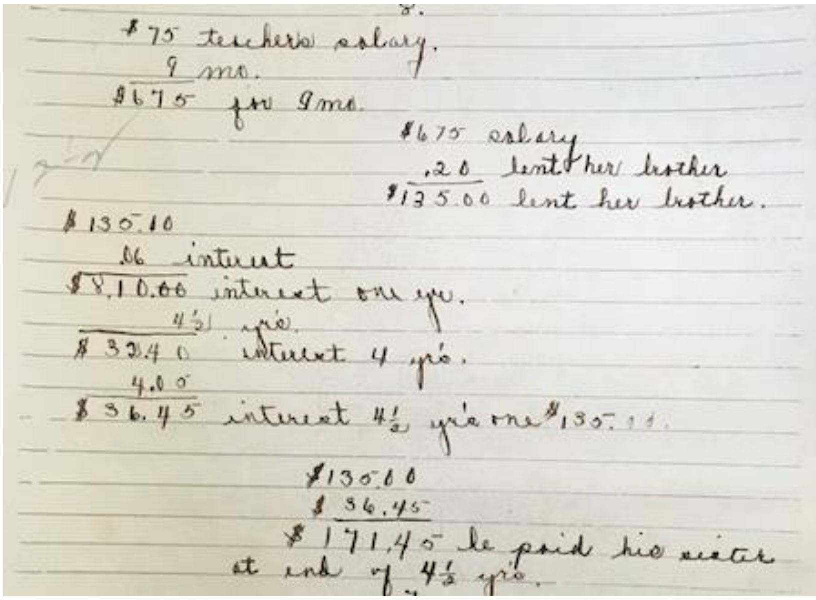
	Q8. A teacher who received a salary of $75 a month for 9 mo. lent her brother at the end of the year 20% of her salary. He kept the money for 4 yr. 6 mo. and then returned it with 6% interest. How much did he pay her?
A. L. Carter	

VIII
$75 per mo. x 9 mo. = $675 salary for the term.
20%
$135.00 Amt. Bro. borrowed.
6%
$8.1000 int. for 1 yr.
4½ yrs.
405
3240
$36.45 int. for 4 yr. 6 mo.
135.00
$171.45 Amt. Ans.
17½

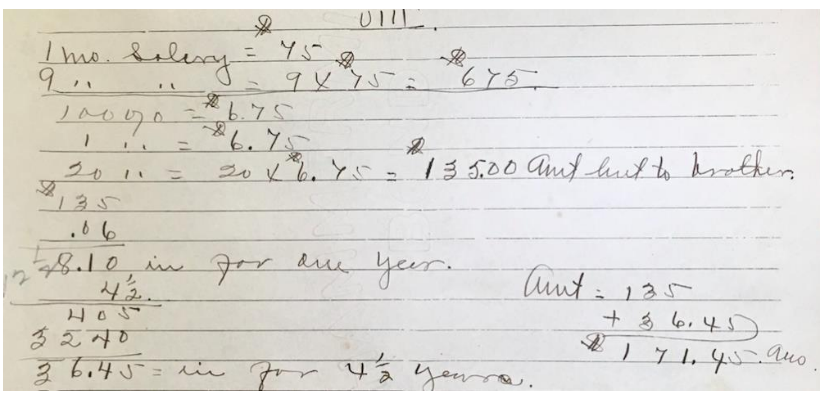
M. R. Johnston


(8) $75 x 9 = 585 Salary for 1 yr. 20% or 1/4 the amount her brother borrowed is 146.25 (1/4 of $585 = $146.25)
$146.25 at 6% interest for 2 yr 6 mo. for 1 yr it is $8.775 x 2 1/2 yr = $21.94 Int. + $146.25 = $168.19 amount paid to her.

M. Burridge


8.
$75 teacher's salary.
9 mo.
$675 for 9 mo.
$675 salary
.20 lent her brother
$135.00 lent her brother.
$135.00
.06 interest
$8.10.00 interest one yr.
4 1/2 yrs.
$32.40 interest 4 yrs.
4.05
$36.45 interest 4 1/2 yrs one $135.00.
$135.00
$36.45
$171.45 he paid his sister at end of 4 1/2 yrs.

L. Harris


1 mo. Salary = $75
9 " " = 9 x 75 = $675
100% = $6.75
1 " = $6.75
20 " = 20 x $6.75 = $135.00 Amt lent to brother.
$135
.06
$8.10 int for one year.
4 1/2
405
3240
36.45 = int for 4 1/2 years.
Amt = 135
+ 36.45
$171.45 Ans.

V. L. Hays

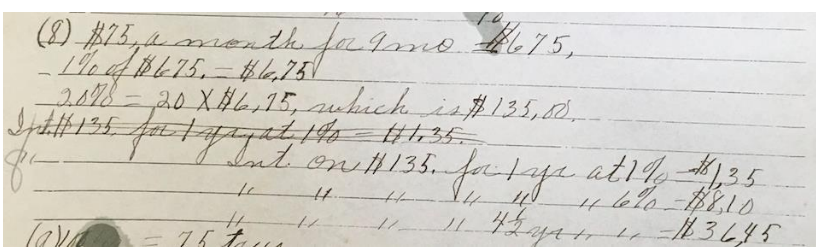
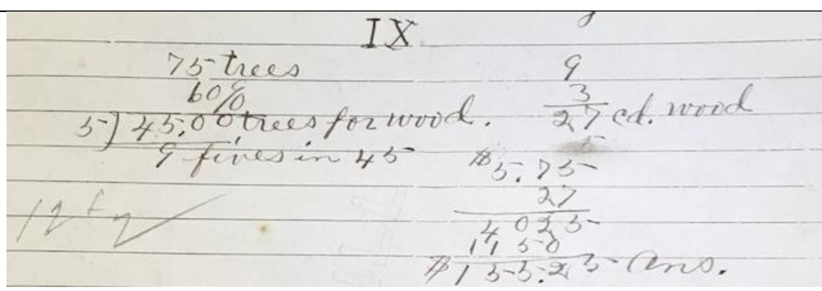
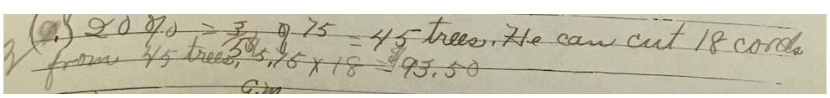

(8) $75, a month for 9 mo. = $675,
1% of $675 = $6.75
20% = 20 X $6.75, which is $135,00
~~Int. $135 for 1 yr at 1% = $1.35.~~
Int. on $135. for 1 yr. at 1% = $1.35
" " " " " " 6% = $8.10
" " " " 4 1/2 yr " " = $36.45

Figure 3. August 20, 1920 - Question 8 Test Taker Responses.

Question nine (Figure 4), the test takers were asked to figure out how much money the farmer would receive for 60% of his trees. Only Carter solved this problem correctly (See Figure

4), she found the correct percentage of trees the farmer cut down, determined the number of cords the farmer would make, and then multiplied the price per cord to find how much money the farmer would receive. Instead of setting it up as a proportion, Carter noted that there were nine fives in 45 and then multiplied nine by three since there were three cords per five trees. Harris, received the second highest score of eight, and this was due to a computation error on the last step of the question. Johnston, M. Burridge, and Hays all received three points for this question. M. Burridge was on the correct path of solving the problem, but when she was finishing the problem, she did not remember three cords, so she forgot to multiply by three before finding the amount the farmer would make. Johnston and Hays answers did not have much shown; when analyzing it the authors questioned where some of their numbers and computations came from. For instance, Johnston computed that there were 18 cords from the trees cut down, but it is not clear how 18 was computed. In Hays's, answer, she multiplied the total number of trees (75) by 1% and got .75 and then said that was equal to $\frac{3}{10}$of 75, but it is unclear where that fraction came from. Regardless, both of their computations resulted in the incorrect answer for this question.

	Q9. A farmer has 75 trees on an acre of woodland, of which he decided to cut 60%. If wood is worth $5.75 a cord and he can cut 3 cords from 5 trees, how much will he receive for the wood?
A. L. Carter	
M. R. Johnston	

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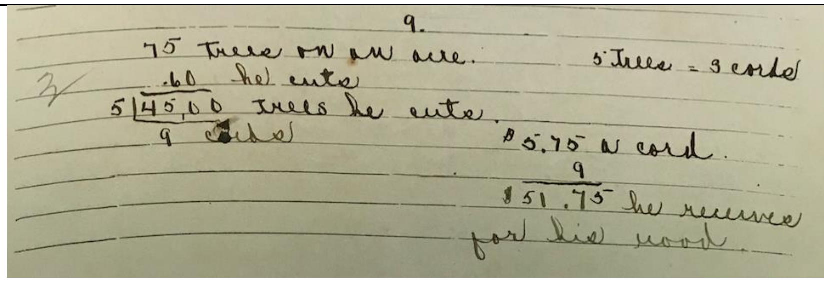
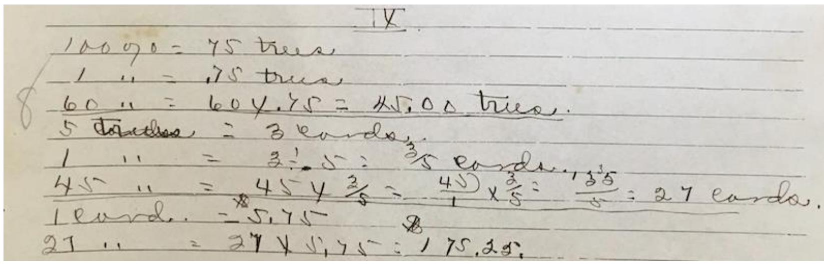
M. Burridge



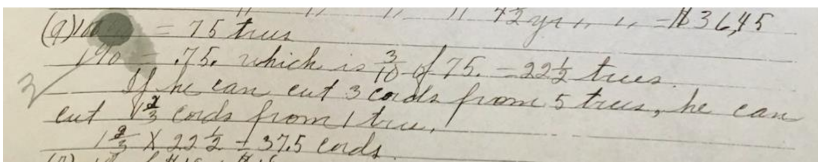
9.
75 Trees on an acre.
.60 he cuts
5|45,00 trees he cuts.
5 Trees = 3 cords
$5.75 a cord.
9
$51.75 he received for his wood.

L. Harris



IX
100% = 75 trees
1 " = .75 trees
60 " = 60 x .75 = 45.00 trees.
5 trees = 3 cords.
1 " = 3÷5 = 3/5 cords.
45 " = 45 x 3/5 = 45/1 x 3/5 = 135/5 = 27 cords.
1 cord. = 5.75
27 " = 27 x 5.75 = 175.25.

V. L. Hays



(9) 100% = 75 trees
1% = .75 which is 3/10 of 75 = 22½ trees
If he can cut 3 cords from 5 trees, he can cut 1⅔ cords from 1 tree.
1⅔ x 22½ = 37.5 cords

Figure 4. August 20, 1920 - Question 9 Test Taker Responses.

For the August 20, 1920 test, there was only one question (See Figure 1, Question 10) not attempted by any of the test takers. This was probably due to the fact that there were 3 different parts to this question. First, they were asked to reduce three fractions to the least common denominator, then they were asked to distinguish between abstract and concrete numbers, and finally they were asked to add three mixed numbers together. Most likely test takers did not like the second step with the vocabulary because the other two parts were simple computational problems.

September 3, 1920 Analysis of Written Answers

On the September 3, 1920 test (See Figure 5), there were a total of 12 questions, of these 12 questions, test takers had to answer any eight. The authors examined the test takers' responses to learn which questions they decided to answer and then analyzed their responses and methods. Each question was worth twelve and a half points, adding to an overall 100 points total for the arithmetic exam. The four test takers each attempted eight questions; all four test takers attempted six of the same questions (Table 7).

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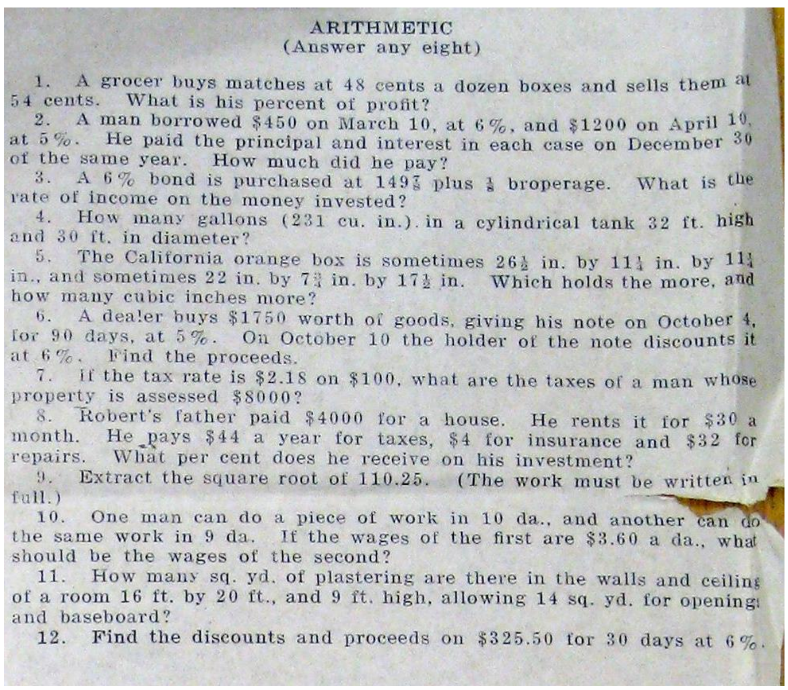
Table 7

Scores on September 3, 1920 Test

Name	1	2	3	4	5	6	7	8	9	10	11	12	Total
E.Erskine	12.5	10			12.5		12.5	12.5		12.5	3	6.5	82
V.L. Hays	10	9			3	3	12.5	3			3	8	51.5
M.R. Johnston	12.5	4			12.5		12.5	4		12.5	3	5	66
L.B. Burridge	3	4			3		12.5	3	3	12.5	3		44


ARITHMETIC
(Answer any eight)

1. A grocer buys matches at 48 cents a dozen boxes and sells them at 54 cents. What is his percent of profit?
2. A man borrowed $450 on March 10, at 6%, and $1200 on April 10, at 5%. He paid the principal and interest in each case on December 30 of the same year. How much did he pay?
3. A 6% bond is purchased at 149$\frac{3}{8}$ plus $\frac{1}{8}$ broperage. What is the rate of income on the money invested?
4. How many gallons (231 cu. in.). in a cylindrical tank 32 ft. high and 30 ft. in diameter?
5. The California orange box is sometimes 26$\frac{1}{2}$ in. by 11$\frac{1}{4}$ in. by 11$\frac{1}{4}$ in., and sometimes 22 in. by 7$\frac{3}{4}$ in. by 17$\frac{1}{2}$ in. Which holds the more, and how many cubic inches more?
6. A dealer buys $1750 worth of goods, giving his note on October 4, for 90 days, at 5%. On October 10 the holder of the note discounts it at 6%. Find the proceeds.
7. If the tax rate is $2.18 on $100, what are the taxes of a man whose property is assessed $8000?
8. Robert's father paid $4000 for a house. He rents it for $30 a month. He pays $44 a year for taxes, $4 for insurance and $32 for repairs. What per cent does he receive on his investment?
9. Extract the square root of 110.25. (The work must be written in full.)
10. One man can do a piece of work in 10 da., and another can do the same work in 9 da. If the wages of the first are $3.60 a da., what should be the wages of the second?
11. How many sq. yd. of plastering are there in the walls and ceiling of a room 16 ft. by 20 ft., and 9 ft. high, allowing 14 sq. yd. for openings and baseboard?
12. Find the discounts and proceeds on $325.50 for 30 days at 6%.

Figure 5. September 3, 1920 Arithmetic Test

The authors analyzed the six questions answered by all four test takers. Question one (See Figure 6) the goal was to find the percent profit a grocer earns selling matchbooks. Figure 6 shows each method the different test takers took to answer the question. Erskine and Johnston were the only two who made a perfect score. Both took different routes to solve the problem, but they both found the difference between what the grocer paid and what was charged for the

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matchboxes. L.B. Burridge only received three points, because she only found the difference between the two costs, but did not finish the entire problem. Hays received ten points and seemed to have the correct idea of how to solve this problem, but rather than finding the difference between the two costs, Hays multiplied the price of the matches by a percent that she calculated. Today, students would find the difference between the cost of the matches and the price and then set up a proportion to determine the profit.

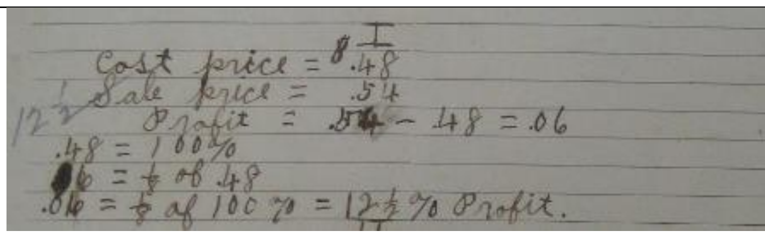
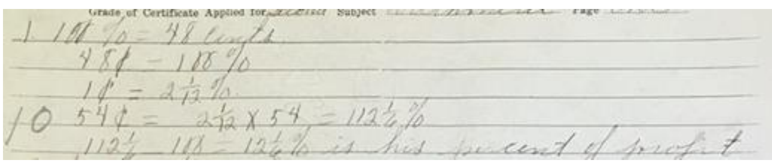
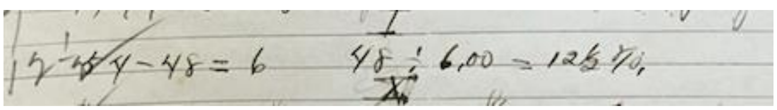
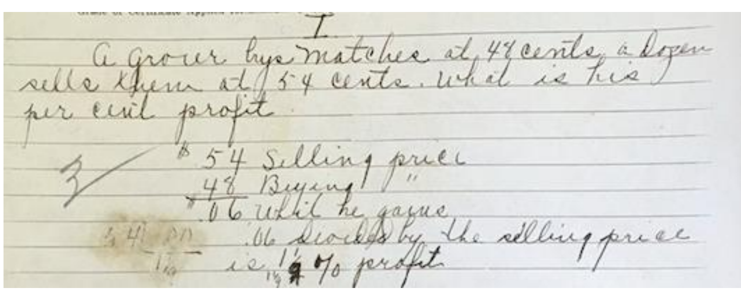
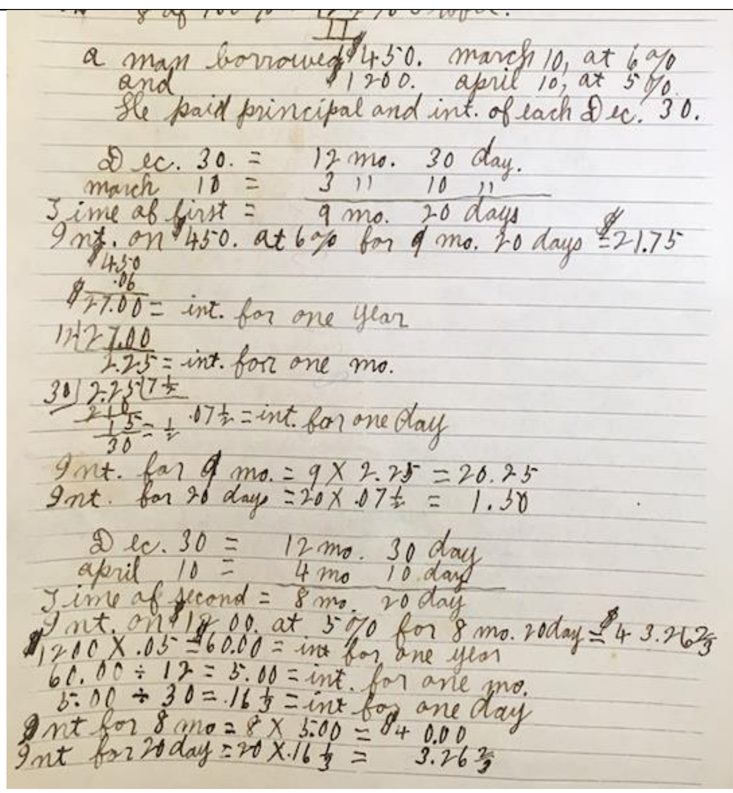
	Q1. A grocer buys matches at 48 cents a dozen boxes and sells them at 54 cents. What is his percent of profit?
E. Erskine	
V.L. Hays	
M.R. Johnston	
L.B. Burridge	

Figure 6. September 3, 1920 - Question 1 Test Taker Responses.

On question two (See Figure 7), none of the test takers made a perfect score. The highest score was a ten by Erskine. Erskine set up the problem correctly (See Figure 7), but made simple computation errors. Hays, who received 9 points, computed one part incorrectly in the beginning when she multiplied by 6% instead of 5%. This simple computation error made the rest of the problem incorrect. Johnston and L.B. Burridge both received four points for this question. Johnston made an error at the beginning of the problem which caused the subsequent steps to be incorrect. When she converted December 30 to months and days, she said it was 12 months and 30 days, rather than the correct 11 months and 30 days. L.B. Burridge made a similar mistake and converted the difference between March 10 and December 30 to be 10 months and 20 days rather than nine months and 20 days. She did this same incorrect conversion for April, saying the difference between April 10 and December 30 was nine months and 30 days rather than eight months and 30 days. For this problem the test takers needed to make note of the days of the month and make sure to compute the interest correctly and be careful when reading the problem to multiply the correct numbers to each other.

<table>
<tr><td></td><td>Q2. A man borrowed $450 on March 10, at 6% and $1200 on April 10, at 5%. He paid the principal and interest in each case on December 30 of the same year. How much did he pay?</td></tr>
<tr><td>E. Erskine</td><td>
II
a man borrowed $450. march 10, at 6%
and $1200. april 10, at 5%.
He paid principal and int. of each Dec. 30.
Dec. 30. = 12 mo. 30 day.
march 10 = 3 " 10 "
Time of first = 9 mo. 20 days
Int. on $450. at 6% for 9 mo. 20 days = $21.75
$450
.06
$27.00 = int. for one year
12)27.00
2.25 = int. for one mo.
30)2.25(7½
2 10
15/30 = ½ .07½ = int. for one day
Int. for 9 mo. = 9 X 2.25 = 20.25
Int. for 20 days = 20 X .07½ = 1.50
Dec. 30 = 12 mo. 30 day
april 10 = 4 mo 10 day
Time of second = 8 mo. 20 day
Int. on $1200. at 5% for 8 mo. 20 day = $43.26⅔
$1200 X .05 = 60.00 = int for one year
60.00 ÷ 12 = 5.00 = int. for one mo.
5.00 ÷ 30 = .16⅔ = int for one day
Int for 8 mo = 8 X 5.00 = $40.00
Int for 20 day = 20 X .16⅔ = 3.26⅔</td></tr>
</table>

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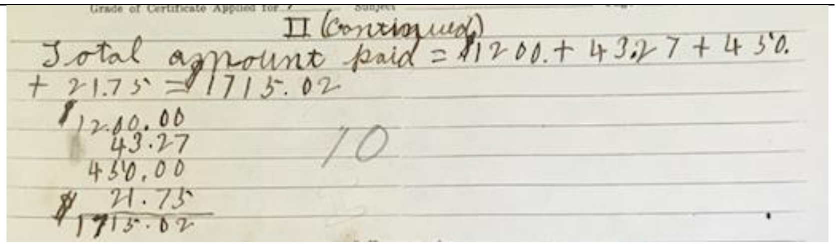
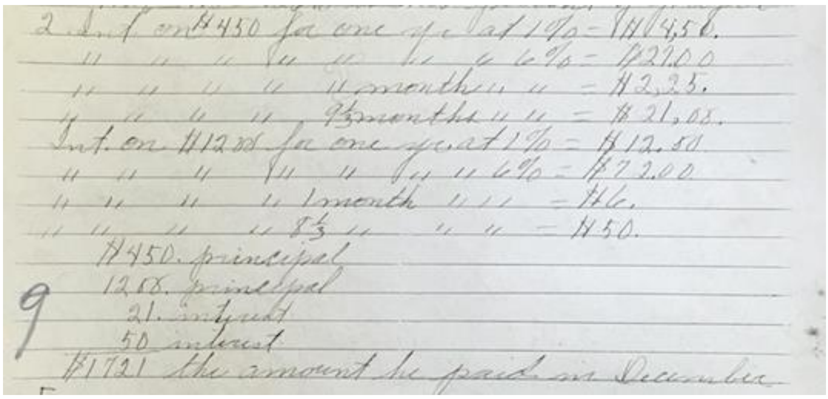
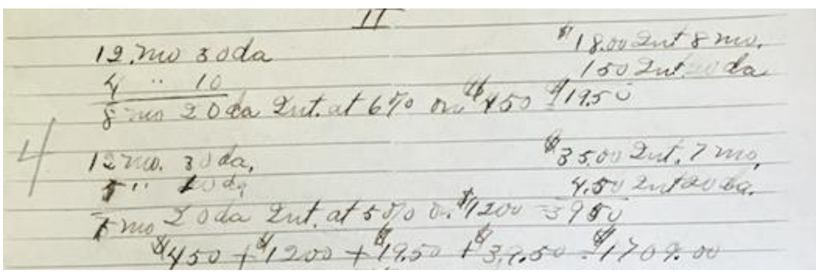


V.L. Hays



M.R. Johnston



L.B. Burridge

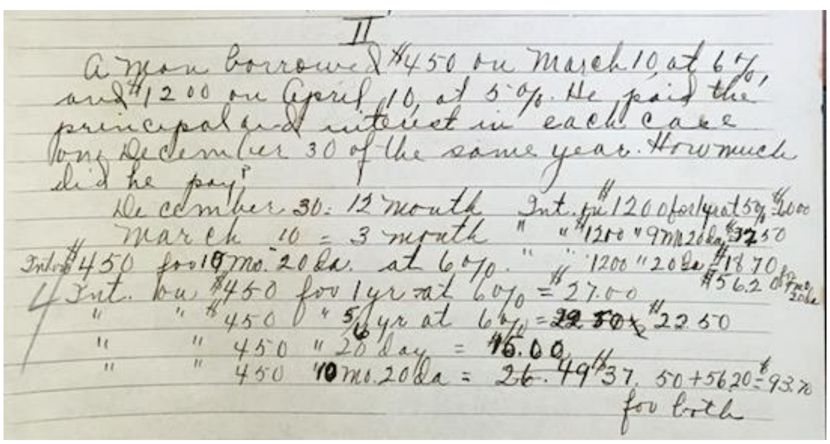
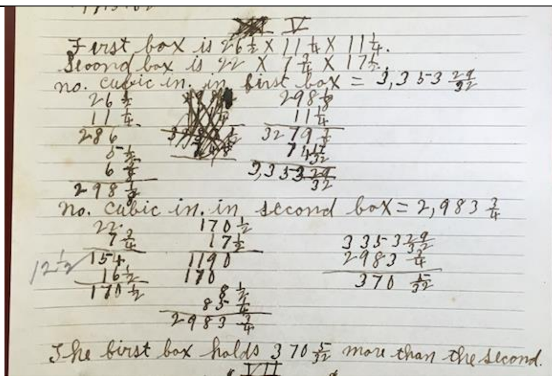
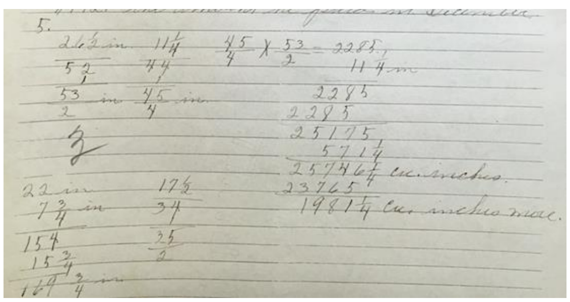
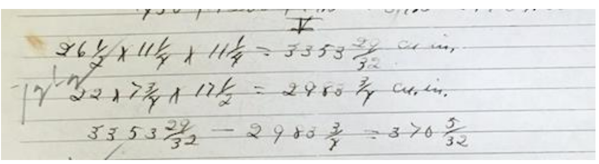


Figure 7. September 3, 1920 - Question 2 Test Taker Responses.

On question five (See Figure 8), two of the test takers earned a perfect score and two earned a three. The test takers who earned a perfect score, solved the question correctly (See Figure 8) by finding the volume of each box, multiplying the three dimensions together, and then subtracting to find the difference, or which one held more. The two who received a perfect score seemed to do mental mathematics by multiplying a whole number by a fraction (Stone,1925, p. 111), but not much written work was shown. Hays, received only three points for question five. She converted the mixed fractions to improper fractions and then multiplied to find the volume of each box. She correctly setup how to solve the problem, but did not compute correctly. She multiplied the numerators of the improper fractions, but did not divide out the denominators, making the final answer incorrect. The authors had trouble understanding Hays method because she used a method that was common in the 1920s but is no longer conventional in the current curriculum.

	Q5. The California orange box is sometimes $26\frac{1}{2}$in. by $11\frac{1}{4}$in. by $11\frac{1}{4}$in., and sometimes 22 in. by $7\frac{3}{4}$in. by $17\frac{1}{2}$in. Which holds the more, and how many cubic inches more?
E. Erskine	
V.L. Hays	
M.R. Johnston	

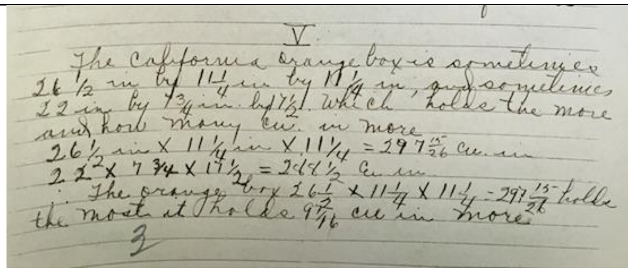
L.B. Burridge	 V. The California orange box is sometimes 26 1/2 in by 11 1/4 in by 11 1/4 in, and sometimes 22 in by 7 3/4 in by 17 1/2. Which holds the more and how many cu. in more 26 1/2 in x 11 1/4 in x 11 1/4 = 2979 15/26 cu. in 22 x 7 3/4 x 17 1/2 = 2441 1/2 cu. in The orange box 26 1/2 x 11 1/4 x 11 1/4 = 2979 15/26 holds the most it holds 9 9/16 cu in more 3

Figure 8. September 3, 1920 - Question 5 Test Taker Responses.

On question seven (See Figure 9), each test taker earned a perfect score of twelve and a half. Each of them divided $100 into $8,000, then multiplied $2.18 by 800 and answered $174.40 as the taxes that would be assessed. The test takers solve the question using proportions, but did not set up the proportion in fraction form (See Figure 9). Today, students would be taught to set up a fractional proportion to solve this question.

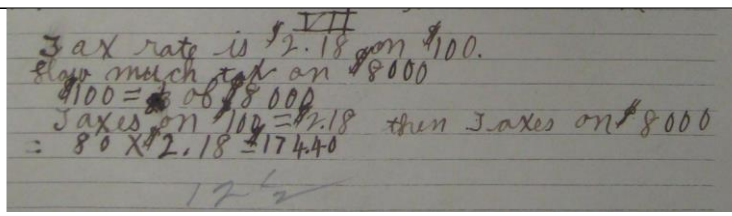
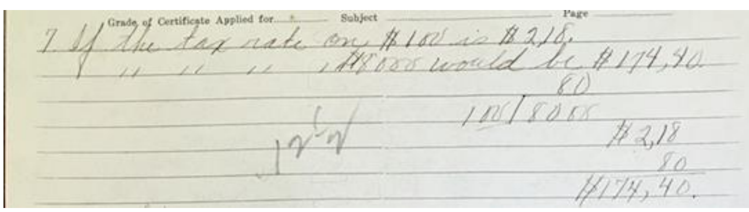
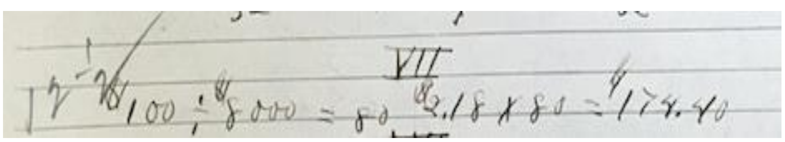
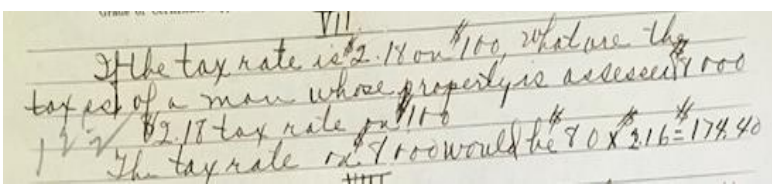
	Q7. If the tax rate is $2.18 on $100, what are the taxes of a man whose property is assessed $8000?
E. Erskine	 VII Tax rate is $2.18 on $100. How much tax on $8000 $100 = 1/80 of $8000 Taxes on 100 = $2.18 then Taxes on $8000 = 80 X $2.18 = 174.40 12 1/2
V.L. Hays	 7 If the tax rate on $100 is $2.18, " " " " , $8000 would be $174.40 80 100 / 8000 $2.18 80 $174.40 12 1/2
M.R. Johnston	 VII 12 1/2 $100 ÷ $8000 = 80 $2.18 x 80 = $174.40
L.B. Burridge	 VII If the tax rate is $2.18 on $100, what are the taxes of a man whose property is assessed $8000 $2.18 tax rate on $100 The tax rate on $8000 would be 80 x $2.18 = $174.40 12 1/2

Figure 9. September 3, 1920 - Question 7 Test Taker Responses.

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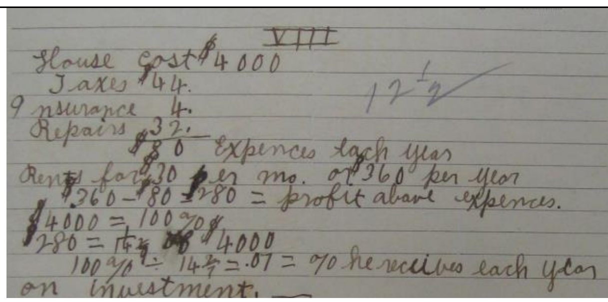
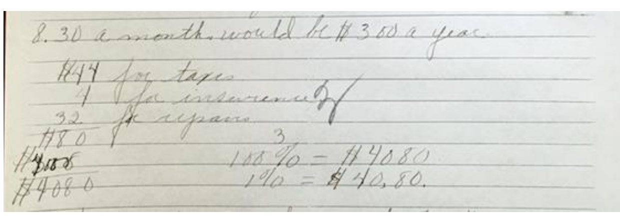
On question eight (See Figure 10), L.B. Burridge and Hays scored three, Johnston scored a four, and Erskine earned a perfect score. There were three different methods used to solve this question by the test takers. Erskine added the total yearly expenses to the total amount of the cost of home, then divided the total by 100 (See Figure 10). Erskine probably realized to make a percentage; you should divide a number by 100. Hays completed the first couple of steps correctly by subtracting the total yearly expenses by the yearly rent, but did not find the percentage the homeowner would receive (See Figure 10, Hays). Johnston received the lowest score. She correctly completed the first steps, but then stopped showing work and ended with an answer that had no proof behind it. L.B. Burridge received full credit and added the yearly expenses, subtracted it by the yearly rent amount of $360. L.B. Burridge then determined the percentage of $280 out of $4000 and found it was 1429. L.B. Burridge then took the percentage and divided it into 100, getting .07. He then converted the decimal to a percentage, either by multiplying by 100 or moving the decimal to the right twice.

	Q8. Robert's father paid $4000 for a house. He rents it for $30 a month. He pays $44 a year for taxes, $4 for insurance and $32 for repairs. What per cent does he receive on his investment?
E. Erskine	
V.L. Hays	

Erskine:

Hays:

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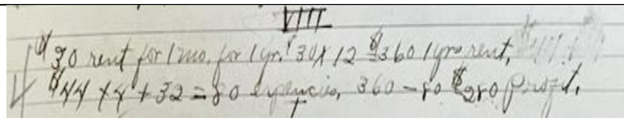
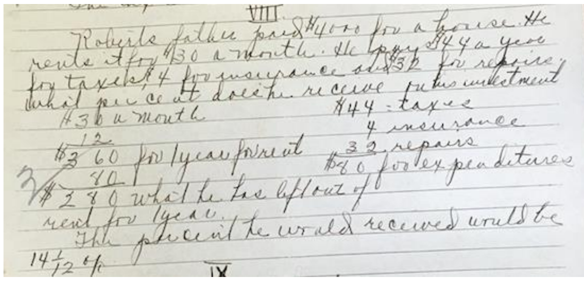
http://www.eijeas.com

M.R. Johnston



VIII
$30 rent for 1 mo. for 1 yr. 30 x 12 $360 1 yrs rent,
$44 + 4 + 32 = $80 expenses, 360 − 80 = $280 profit.

L.B. Burridge



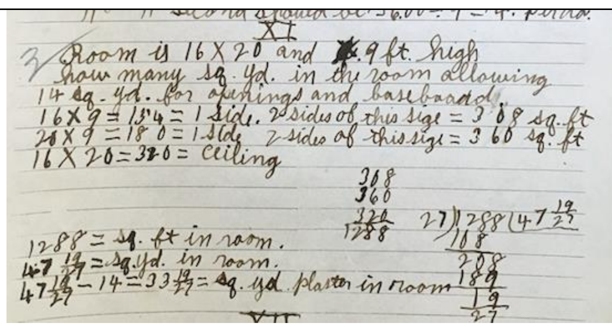
VIII
Roberts father paid $4000 for a house. He rents it for $30 a month. He pays $44 a year for taxes, $4 for insurance and $32 for repairs. What per cent does he receive for his investment
$30 a month
12
$360 for 1 year for rent
80
$280 what he has left out of rent for 1 year.
$44 taxes
4 insurance
32 repairs
$80 for expenditures
The percent he would received would be 14 1/2 %

Figure 10. September 3, 1920 - Question 8 Test Taker Responses.

On Question 11 (See Figure 11), each of the test takers solved the question using a different method and received different results. The test takers most common mistake was not converting square feet to square yards. Another common mistake was the test takers, did not read carefully, they saw three numbers and found the volume instead of finding the area of the different walls of the room.

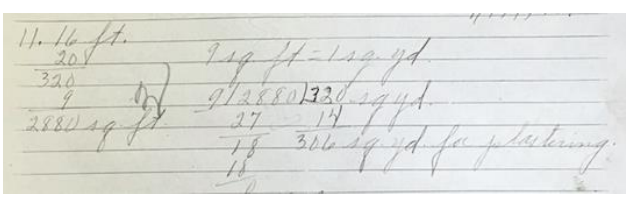
Q11. How many sq. yd. of plastering are there in the walls and ceiling of a room 16 ft. by 20 ft., and 9 ft. high, allowing 14 sq. yd. for openings and baseboard?

E. Erskine



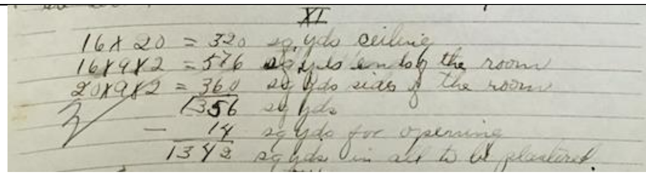
XI
Room is 16 X 20 and 9 ft. high
How many sq. yd. in the room allowing 14 sq. yd. for openings and baseboard.
16 X 9 = 144 = 1 side. 2 sides of this size = 288 sq. ft
20 X 9 = 180 = 1 side 2 sides of this size = 360 sq. ft
16 X 20 = 320 = ceiling
288
360
320
1288
27)1288(47 19/27
1288 = sq. ft in room.
47 19/27 = sq. yd. in room.
47 19/27 − 14 = 33 19/27 = sq. yd. plaster in room

V.L. Hays



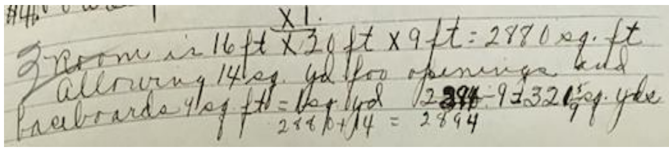
11. 16 ft.
20
320
9
2880 sq. ft
9 sq. ft = 1 sq. yd
9)2880(320 sq yd
14
306 sq yd for plastering.

M.R. Johnston



XI
16 x 20 = 320 sq yds ceiling
16x9x2 = 576 sq yds on both the room
20x9x2 = 360 sq yds sides of the room
1356 sq yds
— 14 sq yds for opening
1342 sq yds in all to be plastered.

L.B. Burridge



#4 XI.
Room is 16 ft X 30 ft x 9 ft: 2880 sq. ft
allowing 14 sq. yd for openings add
baseboards 4 sq ft 2894 9 = 321 5/9 sq. yds
2880+14 = 2894

Figure 11. September 3, 1920 - Question 11 Test Taker Responses.

Next, the authors examined the two problems none of the test takers attempted. Question three had a typo on the word “brokerage”. This typo could have hindered the confidence in the test taker to attempt the question, the test takers may not have known if it was a typo. Question four, the test takers were asked to find how many gallons were in a specific sized cylinder. The units of the cylinders were in feet, and the amount that can fit into a cylinder was in inches. It is probable the conversion of units is what stopped the test takers from attempting the problem.

Conclusion

During the 1920s, persons interested in becoming a teacher had two routes to take, either enroll in a teacher program through a university or normal school or take superintendent administered tests. Those who chose to take the superintendents administered tests had to take and pass 12 tests in order to apply for a 4 or 6 year certificate. One of the tests that had to be taken was arithmetic. The authors transcribed and categorized four test administrations found at the George Memorial Library. The questions were sorted into the following categories: four fundamental operations, fractions and decimal fractions, proportions, percentage, square root and cube root, and measurement. Test taker responses were cross referenced to two of these administrations, August 20, 1920 and September 3, 1920, and the different methods were analyzed for accuracy.

While analyzing the different test questions, it is fascinating to see the different methods of solving problems in the 1920s. Mental math was more common during this time period than it is currently, which makes it so impressive these test takers performed so well on the tests. After analyzing the different problems, the most common mistake made was simple computation errors. Simple computation errors can end up making the entire answer incorrect. Another commonality between the test takers responses was finding the value for one percent if it was a percentage problem. Today most of these percent problems would most likely be solved utilizing proportions. It was very interesting to see the different methods used to solve problems close to one hundred years ago.

The authors also want to highlight that Johnston and Hays took the test during both of these administrations, on August 20, 1920 and on September 3, 1920. During the August 20, 1920 exam Hays did not answer all required eight questions, but still scored higher than when she attempted the test again on September 3,1920, answering the required eight questions. Johnston also scored higher the first time she took the test on August 20,1920 than when she took the test on September 3,1920. Knowing these two test takes' scores went down and comparing what types of questions were selected for each test, the authors assume Hays and Johnston were not as strong in the percentages, proportions, square root and cube root, which were heavily tested during the September 3, 1920 test.

Some readers may wonder why this type of research is important. The tests and teacher responses show what was relevant and valuable in education in the 1920s. The context in each of the questions refer to what life was like in the 1920s and dictate the importance of education by creating a well-rounded individual who would be successful in society. The issues revealed here support current trends in research particularly how language is used, its meaning, and its cultural impact.

Recommendations

Recommendations for further research to be completed on the superintendent administered tests for mathematics include analyzing Algebra and Geometry tests and comparing superintendent administered tests to textbooks used for instruction. This paper focused solely on the arithmetic test that applicants took for temporary teacher certificates. Analysis on the Algebra and Geometry tests will further help understand the content knowledge that teachers needed in the 1920s to apply for a permanent (lifetime) certificate. Questions from these two tests can be classified by their content area and, when possible, analyze test taker responses and performance on these items. Furthermore, research can also be done to correlate content found on the superintendent administered test to the content found in textbooks during the 1920s. This correlation can help determine if what was expected on the tests were actually taught in the curriculum, and how this content was taught or presented during the 1920s. Analyzing past teacher exams and content knowledge allows researchers to get a glimpse into what was important to education during this time period and determine how education has evolved.

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