

Chinese Students' Basic Computation Ability: An Assessment on Third Grade Students

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In the current study, 1958 students were randomly selected from 46 classes in 22 elementary schools in the Jiangsu province. Three tests were provided for participants. The first test focused on basic mental computation, the second test focused on (addition, subtraction, multiplication and division) mental computation below 100, and the third test focused on written computation. The results of the development of the computational ability of elementary students of Jiangsu is normal, and the results showed that there has no evidence to show that students' computational ability has decreased as a result of the reformed curriculum.

Key words: basic computation, computation ability, computation accuracy, computation speed

Introduction

Computation is one of the key contents in elementary and middle school level mathematics education in China. Decades ago, Chinese "arithmetic curriculum", with an emphasis of basic computation skills contained as the main contents whole number computation, decimal computation, fraction computation, mix number computation and problem solving. In 1978, the "arithmetic curriculum" was re-titled as the "mathematics curriculum". In the new curriculum, the pre-algebra and basic geometry contents as well as the idea of simple set and function theory were added; some over-complicated computation, complicated mix-number computation and problem solving contents were deleted. Though there were some revisions in the computational contents, however, all versions of the mathematics curriculum in China still require students to "do computation accurately and rapidly" as well as "adopt suitable computation methods flexibly". By using enough time on learning and training computation, most Chinese students are able to do computation with a higher accuracy rate and faster than their peers from Western countries.

For a long time, the Chinese mathematics educators and researchers were proud of their students' solid fundamental knowledge and strong basic skills in computation. As Zhang (2006) noted, Chinese students' high achievement in mathematics is strongly related with Chinese schools' emphasis on training of basic knowledge and basic skills. According to Zhang's perspective, reciting multiplication tables as well as other arithmetic algorithms facilitates students in understanding mathematics concepts, and rote drilling in various forms of questions promotes students' mathematics thinking development. However, Chinese students' creativity and critical thinking ability in mathematics is weak compared with their international peers.

As basic computation ability is not enough to educate all-round-well-developed students, the new curriculum reform decreased the requirement for computation and deleted the standards on computational accuracy. Rather, only the standards for computation speed were listed for the first grade band (grade 1-3). Educators have inconsistent ideas about whether students' computation ability should be developed as well as what importance the computation should have in the mathematics curriculum. Some educators argue that it is

unnecessary for students to master computation skills since the national standard had deleted this content, and Chinese standards for computation are still higher than most Western countries. Other educators claim that the students in the current era have very poor computation skills and we cannot decrease our standards anymore. In order to investigate Chinese students' ability in computation, the current research assessed basic computation skill among third grade students in Jiangsu rural areas; specifically, we investigated the speed and accuracy of doing computations.

Cai (2007) assessed mathematics performance between Chinese and US elementary school students by using three tasks. The results showed that the accuracy rate among Chinese students was 88% ($n=310$), and the accuracy rate among US students was 48% ($n=232$). Cai's study showed that Chinese students' computation ability is significant higher than US students, while their ability on proposing questions is significant lower than US students. Zhang (2004) assessed 5135 students in 92 elementary schools from 15 districts in the Sichuan province, and the results showed that the average accuracy rate is 87.49%. Zhang's study showed that students from rural areas have more variances on the computational ability than students in urban areas. Wu (2005) assessed 491 six grade students in Southeast China regarding their conceptual understanding, computational skill and mathematics application, and he found that the accuracy rate of addition and subtraction is 95%, 91% and 98% respectively. Wu (2005) found that students' computational ability was significantly higher than their conceptual understanding and mathematics application. The Elementary Education Curriculum and Textbook Development Center of Education Department of China assessed 1126 schools in 2006 and 1521 schools in 2008 on students' achievement, and the results demonstrated that the accuracy rate of three digit subtraction and division is around 92%, which is higher than not only the current curriculum requirement but also the old curriculum requirements.

Methods

Participants

The target population of the current study is third grade students in the Jiangsu Rural area. Based on the geographical location as well as economical level, the sample was divided into three parts. In the current study, 1958 students were randomly selected from 46 classes of 22 elementary schools. The purpose of the study is to investigate third grade students' accuracy and speed of computation.

Instruments and Procedure

Three tests were provided to participants. The first test focused on basic mental computation, the second test focused on (addition, subtraction, multiplication and division) mental computation below 100, and the third test focused on written computation. The time limitation for each test was five minutes and the three tests were provided consecutively. A break was provided for students between each test.

The content of the tests that we designed was based on the content that third grade students had learned. Specifically, in the first test 48 questions were assigned to students and the main assessment was on the addition and subtraction with place value below 20; moreover, multiplication and division within multiplication table were assessed. In the second test, 36 questions were assigned to students and the main assessment was on the addition and subtraction with place value below 100; some questions did not include place value. In the second test, 36 questions were assigned to students and the main assessment was on the

addition and subtraction with place value below 100; moreover, some questions did not include place value. In the third test, 10 questions were assigned for students and the main assessment was on the addition and subtraction with place value below 1000.

Results

Error Rate of Mental Computation and Written Computation among Different Areas

Table 1 and 2 showed error rate of mental computational and written computation among different areas and accuracy rate of mental computational and written computation among different areas.

Table 1

Error Rate of Mental Computational and Written Computation among Different Areas

		South	Middle	North	Total
Test 1	Average accuracy	96.16	96.46	95.38	95.84
	All correct	36.94	33.69	31.37	33.86
	1-2 errors	36.15	39.72	35.40	36.31
	3-5 errors	20.84	19.50	23.31	21.81
	More than 5 errors	6.07	7.09	9.91	8.02
Test 2	Average accuracy	95.36	96.00	94.59	95.09
	All correct	44.33	42.55	34.53	39.48
	1-2 errors	35.49	38.30	40.63	38.30
	3-5 errors	13.59	12.06	16.88	14.91
	More than 5 errors	6.60	7.09	7.95	7.30
Test 3	Average accuracy	90.08	90.14	86.17	88.25
	All correct	50.13	40.78	34.86	41.62
	1-2 errors	38.26	47.16	45.64	43.00
	More than 3 errors	11.61	12.06	19.50	15.37

Table 2
**Accuracy Rate of Mental Computational and Written Computation
 among Different Areas**

	South	Middle	North	Total	
Test 1	Mental addition below 20 (10 items)	98.64	98.01	97.90	98.20
	Mental subtraction below 20 (10 items)	98.28	97.91	97.88	98.04
	Mental multiplication below 10 (8 items)	98.45	97.03	97.71	97.90
	Mental division below 10 (10items)	97.39	97.66	96.57	97.04
	Two digit number addition (4 items)	76.68	86.70	78.24	78.86
	Two digit number subtraction (4 items)	96.57	95.57	93.11	94.80
	Two digit number multiplication (2 items)	95.98	94.50	93.90	94.79
Test 2	Two digit number add one digit number (4 items, such as 12 + 3)	95.91	96.54	95.51	95.81
	Two digit number subtract one digit number (6 items)	95.10	96.04	94.75	95.07
	Two digit number add/subtract two digit number without place value (4 items)	96.50	96.81	96.13	96.37
	Two digit number add/subtract two digit number with place value (8 items)	94.13	95.17	92.85	93.68
	Two digit number multiplication (without place value) (3 items)	98.02	96.69	96.59	97.16
	Two digit number division (without place value) (3 items)	97.27	97.40	95.13	96.29
	Test 3	One digit number computation (8 items)	94.23	95.35	94.02
Three digit number addition (2 items)		94.26	91.49	90.09	91.91
Three digit number subtraction (2 items)		85.36	84.22	79.47	82.43
Two digit number multiplication (3 items)		87.99	90.78	83.66	86.36
Two digit number division (3 items)		92.52	92.55	90.52	91.59

Speed of Computation

Table 3 showed the percentage of speed of mental computational and written computation.

Table 3
The Percentage of Speed of Mental Computational and Written Computation

	South	Middle	North	Total	
Test 1	Finished within 4 minutes	87.20	80.50	80.28	82.99
	Finished within 5 minutes	96.57	96.45	94.01	95.35
	Not finished within 5 minutes	3.43	3.55	5.99	4.65
Test 2	Finished within 4 minutes	83.38	76.95	69.93	76.15
	Finished within 5 minutes	95.25	96.81	93.25	94.54
	Not finished within 5 minutes	4.75	3.19	6.75	5.46
Test 3	Finished within 4 minutes	75.99	72.34	62.85	69.31
	Finished within 5 minutes	96.17	97.16	93.14	94.89
	Not finished within 5minutes	3.83	2.84	6.86	5.11

The Difference among Schools

Table 4 showed the differences on computational accuracy rate among different schools.

Table 4
The Differences on Computation Accuracy Rate among Different Schools

	D	E	M	P
Mental addition below 20 with place value	97.33	99.56	96.11	97.31
Mental subtraction below 20 with place value	96.00	99.29	93.89	98.08
Mental multiplication within multiplication table	96.96	99.32	93.75	98.08
Mental division below multiplication table	93.95	99.18	92.78	95.38
Mental addition of two digit numbers	64.17	81.97	83.33	92.31
Mental subtraction of two digit numbers	91.07	99.59	86.11	94.23
Mental multiplication of simple two digit numbers	92.86	97.27	91.67	98.08
Mental addition of simple two digit numbers without place value	92.38	98.77	87.50	96.15
Mental addition/substaction with place value (a one digit number with a two digit number)	90.16	97.36	91.67	96.15
Mental addition/substaction without place value(a two digit number with a two digit number)	93.45	98.77	98.61	94.23
Mental addition/substaction with place value(a two digit number with a two digit number)	87.56	98.77	87.50	95.19
Mental multiplication without place value(a one digit number with a two digit number)	96.19	99.27	98.15	98.72
Mental division without remainder(a one digit number with a two digit number)	93.49	99.45	87.04	96.15
Mental addition with multiplication/subtraction with division)	90.89	98.02	86.11	92.79
Written addition (a three digit number with a two digit number)	88.33	98.90	50.00	94.23
Written subtraction(a three digit number with a two/three digit number)	67.38	95.63	75.00	94.23
Written multiplication(a two digit number with a two digit number)	77.46	95.45	79.63	92.31
Written division(a three digit number with a one digit number)	84.92	97.81	85.19	94.87

The Difference among Classes

Table 5 and 6 showed the differences on computational accuracy rate and speed among different classes.

Table 5
The Differences on Computation Accuracy Rate among Different Classes

	E1	B1	G2	T2	K1
Mental addition below 20 with place value	99.80	99.15	96.63	94.88	93.40
Mental multiplication/division within multiplication table	99.77	99.53	95.51	92.33	93.78
Mental addition/subtraction of two digit numbers	98.33	95.99	90.91	86.47	91.64
Mental division without remainder(a one digit number with a two digit number)	99.66	97.46	94.23	90.48	94.47
Written addition/subtraction (a three digit number with a two digit number)	95.41	95.76	77.88	75.00	76.00
Written multiplication/division(a two digit number with a one/two digit number)	97.96	92.94	89.74	71.43	74.67

Table 6
The Differences on Computation Accuracy Rate and Speed among Different Classes

		D2	D4	D5
Test 1	Finished below 4 minutes	100	50	80.85
	Finished below 5 minutes	100	69.57	89.36
	Not finished below 5 minutes	48	20	35
	All correct	25.64	10.87	19.15
	1-2 errors	43.59	34.78	25.53
	3-5 errors	20.51	30.43	38.30
	More than 5 errors	10.26	23.91	17.02
Average accuracy		95.19	87.64	92.99
Test 2	Finished below 4 minutes	100	56.52	74.47
	Finished below 5 minutes	100	69.57	91.49
	Not finished below 5 minutes	36	12	30
	All correct	51.28	13.04	14.89
	1-2 errors	35.90	41.30	34.04
	3-5 errors	12.82	19.57	40.43
	More than 5 errors	0	26.09	10.64
Average accuracy		97.29	81.26	91.49
Test 3	Finished below 4 minutes	100	36.96	63.83
	Finished below 5 minutes	100	71.74	82.98
	Not finished below 5 minutes	10	7	8
	All correct	33.33	13.04	23.40
	1-2 errors	58.97	36.96	44.68
	3-5 errors	7.69	50.00	31.91
	Average accuracy		89.74	64.00

Discussion

The result of the oral test and the written test shows that elementary students in rural areas of Jiangsu have a high accuracy rate in general. Specifically, students' mental computation ability exceeded the standard requirements and students' written computational ability met the standard requirements. Moreover, students' computational speed exceeded the standard requirements.

The current mathematics curriculum standard (experimental version) does not have a quantitative standard for elementary students' computation. The Department of Basic Education in the Ministry of Education in China in 2007 released a draft of mathematics standards open to comments with revisions. In this standard, some requirements for third grade computational accuracy were proposed: At the end of the third grade, students' average mental computational accuracy rate for addition/subtraction below 20 and multiplication/division on the multiplication table should achieve 95%; students' average written computational accuracy rate for three digit addition/subtraction, two digit multiplication and division of three digit/two digit and one digit numbers should be 90%. Our results showed that elementary students in the rural area of Jiangsu have a high accuracy rate for basic computations - their average accuracy rate for mental computations exceeded the standard requirements; their written computation of addition and division met or was close to the standard requirements; and their written computation of subtraction and multiplication was close to the standard requirements. Even based on the requirements before the curriculum reform, except for the three digit number addition, all the mental computations

achieved the requirement; except for subtraction, all the written computations achieved the requirement.

According to the current standard, at the end of the third grade, students' computational speed should meet following requirements: for eight to ten questions of addition / subtraction below 20 per minute, for two to three questions of three digit addition / subtraction per minute, for one or two questions of two digit multiplication, and division of three digit/two digit and one digit number per minute. The results of the current study showed that elementary students in the rural areas of Jiangsu demonstrate high speed for basic computations. Most students achieved or exceeded the speed requirements in the standard - 95% of students in the current assessment exceeded the current standards; they even achieved the previous standard on both mental computation and written computation, which has a higher requirement on computation.

The results of the current study showed that elementary students' computational ability has no direct correlation with the geographical area as well as social economic development levels. The results of the mental computational test showed that the accuracy rate among areas of south, middle, and north of Jiangsu province are very close, and show no statistically significant difference. On the written computational test, the southern and middle areas approximate the achievement standard, while the average accuracy rate in the northern area is 2% to 4% lower than the southern and middle areas. However, the schools which have the highest as well as lowest accuracy rate on the questions of two digit multiplication, and division of three digit/two digit and one digit number are in the northern area.

The results showed that elementary students' computational ability has a direct correlation with the schools' administration level as well as the status of how well the instructions were made based on the standards, especially if correlated with teachers' instructional perspective, instructional method, the understanding of curriculum standards and textbook, and the school requirement for mathematics learning.

Conclusion

Based on all the results, we could make the following conclusions: First of all, the development of computational ability of elementary students of Jiangsu is normal. There was no evidence to show that students' computational ability was decreased by using the reformed curriculum. Moreover, the standard of computation in the current mathematics curriculum is attainable with the current instructional practices. Most schools can achieve the requirement of computational ability for students based on the current curriculum standard. Furthermore, students' computational ability should be developed from the first grade. Besides teaching students the algorithm and the computational rules, students have to build strong skills in mental computation of addition and subtraction below 20 as well as multiplication and division on the within multiplication table. Finally, as The Department of Basic Education in the Ministry of Education in China in 2007 addressed in the draft of mathematics standard open to comments with revisions that teachers need to help students build their computational ability and that the training of computational skill still needs much practice so teachers have to provide effective training for students and teachers should avoid repeated practices. Teachers need to improve students' accuracy rate and their speed of computation; however, the amount of practice should be reasonable. The future research is needed to assess sixth grade students' computational ability by comparing the development of computational ability before and after the curriculum reform.

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