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The Abacus: Instruction by Teachers of Students with Visual Impairments

Sheila Amato, Sunggye Hong, and L. Penny Rosenblum

Structured abstract: *Introduction:* This article, based on a study of 196 teachers of students with visual impairments, reports on the experiences with and opinions related to their decisions about instructing their students who are blind or have low vision in the abacus. *Methods:* The participants completed an online survey on how they decide which students should be taught abacus computation skills and which skills they teach. Data were also gathered on those who reported that they did not teach computation with the abacus. *Results:* The participants resided in the United States and Canada and had various numbers of years of teaching experience. More than two-thirds of those who reported that they taught abacus computation skills indicated that they began instruction when their students were between preschool and the second grade. When students were provided with instruction in abacus computation, the most frequently taught skills were the operations of addition and subtraction. More than two-thirds of the participants reported that students were allowed to use an abacus on high-stakes tests in their state or province. *Discussion:* Teachers of students with visual impairments are teaching students to compute using the Cranmer abacus. A small number of participants reported they did not teach computation with an abacus to their students because of their own lack of knowledge. *Implications for practitioners:* The abacus has a role in the toolbox of today's students with visual impairments. Among other implications for educational practice, further studies are needed to examine more closely how teachers of students with visual impairments are instructing their students in computation with an abacus. Topics to examine include the frequency of instruction, the age at which instruction begins, how instruction is provided to children with multiple disabilities, whether instruction is provided in the general education classroom or via pullouts, the role of math teachers and paraeducators in instruction, and how the abacus could be used collaboratively with technology.

The expanded core curriculum (ECC), initially conceptualized by Hatlen (1996), is well accepted in the field of education of children who are visually impaired as a model of inclusive and high-quality education. Professionals in the field agree that knowledge of math, identified as part of the compensatory access–academic skills area of the ECC, is essential for children who are visually impaired. It is well established that children who are visually impaired should learn math skills at the same level as their sighted peers (Tindell, 2006). Yet, the curricular area of math for these students has received little research attention (DeMario, Lang, & Lian, 1998; Lohmeier, 2008). A case in point is the fact that only two studies in the past decade, one by Wolffe and colleagues (2002) and the other by Rule, Stefanich, Boody, and Peiffer (2011), examined the role of teachers of students with visual impairments in delivering services to their students. In neither study did the authors mention the abacus as a tool used by students with visual impairments.

Despite the dearth of studies in this area, some professionals in the field believe in the value of the abacus for use by those with visual impairments. For example, Millaway (2001, p. 1) stated: "The Cranmer Abacus is generally regarded by special educators as the best all-around computing device available to blind students. Therefore, teachers of the visually impaired must be prepared to provide instruction to their students on the use of the Cranmer Abacus." *Braille Mathematics Standards* (California Department of Education, 2006) specifies graded-level math competencies that recognize the importance of the abacus for children with visual impairments. Kapperman, Heinze, and Sticken (1997) noted that the abacus is useful because of its speed, accuracy, portability, and flexibility. According to Kapperman, Heinze, and Sticken (2000), abacus users benefit from the ability to manipulate the beads concretely, which ultimately leads to a greater understanding of numbers than would be gained from use of a calculator. Whether a student receives or does not receive instruction in computation using an abacus is often dependent on the attitude of the teacher of students with visual impairments. "A teacher's competence and attitude have a great impact on a student's potential for success with the Cranmer Abacus. Therefore, a teacher must be skilled in the use of the Cranmer Abacus, convey a positive attitude toward it, and demonstrate its relevance to the student" (Kapperman et al., 2000, p. 385). Children must also be given opportunities to use an abacus within the general education classroom (Culpepper, 2001) and be taught in an educational environment in which the abacus is viewed positively (Kapperman et al., 1997; Lohmeier, 2008).

As part of a larger study, approved by the Institutional Review Board at the University of Arizona, data for this study were gathered about the experiences of teachers of students with visual impairments in teaching computation with an abacus to their students. Topics for which data were gathered included the age at which instruction began, criteria for determining if abacus instruction was appropriate for a student, and the abacus skills taught to the students. Data were also gathered from teachers who reported that they do not teach computation with

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an abacus to students with visual impairments in an attempt to learn how and why these teachers decided not to provide this instruction.

Methods

Instrument

The survey gathered demographic data on the participants through eight questions (such as age, gender, and number of years employed as a teacher of students with visual impairments). The participants were then asked to respond to an online survey that was developed to gather data on how the participants were prepared to use an abacus for computation; their attitudes toward the effectiveness of the abacus as a computational tool for students who are visually impaired; whether they teach computation with an abacus to their students; and, if so, which skills they teach. Information on the first two areas of the survey is reported in Rosenblum, Hong, and Amato (2013), which contains a detailed description of the survey instrument.

Recruitment

The study was advertised on national electronic bulletin boards in the field of visual impairment. We also contacted individuals we knew who had completed their university preparation at one of the universities at which we currently or previously taught who might not be participants in national or local professional online networks.

Results

A total of 196 individuals completed the survey. This section reports the data gathered from the participants about their experiences teaching the abacus to students who are visually impaired. Not all the participants completed all the questions, so the number of participants who responded to a specific question is reported when the total number of respondents for the question is not 196. Demographic data on the participants are reported in Rosenblum and colleagues (2013).

Abacus instruction for students with visual impairments

There were 122 participants who currently or in the past taught abacus computation to students with visual impairments. The number of students in their caseloads who were using an abacus in their math classes during the 2011–12 school year ranged from 0 to 10 as reported by 148 participants. Fifty (33.8%) did not have a student who used an abacus in a math class, 49 (33.1%) had 1 student, 26 (17.6%) had 2 students, and the other 23 (15.5%) had 3 to 10 students. A teacher of students with visual impairments in an elementary school commented, "It is incredibly empowering, especially for younger students who are just moving past simple addition. I think the abacus helps them think of the math in a different way: less memory and rote, more processing the numbers."

Use of an abacus on high-stakes tests

A series of questions was posed to the participants about instructing their students in the use of an abacus. Of the 168 participants who responded, 121 (72%) reported that students were allowed to use an abacus on high-stakes tests in their state or province, 2 (1.2%) reported that an abacus was not permitted, and 45 (26.8%) were unsure. Sixty-three participants provided comments about high-stakes testing, including many who offered the analogy that the abacus is like a pencil and paper for sighted students. "Its use should be permitted any time a sighted student is allowed 'scratch paper' (or the test margins) for working out problems." "It is a tool, equivalent to paper [or] pencil for students who are [blind or visually impaired]. Students must know how to add, subtract, multiply, and divide to use the abacus, so it is not equivalent to a calculator." Some teachers commented on their students' preference for using technology, especially in the higher grades: "By the time my students are in high school, they would usually rather use the talking calculator than the abacus, so although it is listed as an accommodation, I can't remember any students using their abacus past about [the] 5th grade."

Abacus goals on Individualized Education Programs

When asked if their students had goals related to the abacus on their Individualized Education Programs (IEPs) for the 2011–12 school year, 147 participants responded. Of the 147, 69 (46.9%) reported that their students did not have IEP goals for an abacus, 42 (28.6%) had 1 student with such goals, 18 (12.2%) had 2 students with such goals, and 18 (12.3%) had 3 to 6 students with such goals. One participant observed, "Students who were allowed to have abacus skills on their IEP often enjoyed instruction. If the regular classroom teacher and/or classroom aide was able to learn with the student, things went very well."

Methods of instruction and skills taught to students

The participants were asked which methods of instruction they used to teach their students to compute using an abacus. Multiple responses were allowed. A description of the methods for computation is presented in Box 1. Of the 148 participants who responded, 71 (48.0%) used the counting method, 57 (38.5%) used a combination of methods, 51 (34.5%) used the logic-partner method, 28 (18.9%) used the paper-compatible method, 21 (14.2%) used the secrets method, 17 (11.5%) used the Hadley School for the Blind method, 12 (8.1%) did not recall the name of the method they used, and 7 (4.7%) used a method they developed. Several of the written comments supported the perceptions that some preservice training programs did not provide the participants with adequate exposure to a variety of computational methods on the abacus. One participant noted, "I teach the way I was taught, and I have had to switch a student because [he or she was] taught another method but could not compute accurately." Yet an encouraging theme of the comments revolved around the teaching strategy of using the abacus as a tool to teach place value: "I love using the abacus right away to help with understanding place value. [It] makes it so easy to braille [or] write the answers with the commas in the correct place by copying from the abacus."

The participants were asked at what age they typically begin introducing the abacus to their students. Of the 137 who responded, 24 (17.5%) did so during preschool, 55 (40.1%) did so during kindergarten, 36 (26.3%) did so during the first grade, 9 (6.6%) did so during the second grade, 6 (4.4%) did so during the third

Descriptors of instructional methods

Logic or partner method. This method focuses on understanding the "what" and "why" of the steps in solving a problem on the abacus. It requires that the student know the partners or complements of the numbers up to 10 (5=2+3, 5=1+4). This method uses synthesis when beads cannot be set directly. Verbalizing the steps and the reasons for each movement made on the abacus is an important feature of this approach (Livingston, 1997).

Secrets method. This method focuses on the process of moving the abacus beads in a particular sequence, following a specific set of rules for different numbers and operations. It does not emphasize the understanding of that process, rather the rote memory of the bead movements (Davidow, 1988).

Counting method. This method has the student count each bead as it is added or subtracted, moving from the unit beads to the 5 beads (but counting only 1 for all beads). There are also specific rules regarding certain numbers and operations, but fewer than the full set of secrets (Millaway, 2001).

Paper-compatible method. The paper compatible method has the user complete problems in the same way an individual completes them using paper and pencil. The standard math facts are used, not the secrets or a series of questions (Willoughby & Duffy, 1989).

Hadley School for the Blind method. Hadley School for the Blind uses the indirect method to teach the abacus. The indirect method combines both the logic or partner method and the secrets method. Complements are explained and students are expected to use that understanding to follow a specific set of rules for adding and subtracting.

Box 1.

grade, 3 (2.2%) did so during the fourth grade, 2 (1.5%) did so during middle school, and 2 (1.5%) did so during high school. Some participants commented that the introduction of the abacus depended on the developmental level and the ability of a student to understand the basic concepts of the tool. Others introduced the abacus when it made sense to do so in the academic curriculum. One participant explained the rationale for the choice: "When students' peers are asked to count (e.g., in many preschools, children count the days of the month, etc.), we just count right along by moving beads when counting."

The participants were given a list of factors to consider when determining when to begin instruction in an abacus, with multiple responses allowed. Of the 148 participants who responded, 105 (70.9%) considered a student's academic abilities, 71 (48.0%) considered whether a student is blind, 67 (45.3%) considered a student's fine motor abilities, 49 (33.1%) considered a student's grade in school, and 24 (16.2%) each considered a student's chronological age and whether the student has low vision. The participants taught students from kindergarten through high school. Their comments covered the full range of grade placement and students'

Table 1
The abacus skills that the 146 participants taught to students by educational setting (*N;* % in parentheses).

Skill	Total	Itinerant or travel (n = 111)	Resource room or self-contained classroom (n = 16)	Residential or specialized school (n = 19)
One-digit addition without synthesis or secrets	113	88 (77.9)	12 (10.6)	13 (11.5)
Addition of two or more digits without synthesis or secrets	109	85 (78.0)	12 (11.0)	12 (11.0)
One-digit subtraction without synthesis or secrets	99	76 (76.8)	1 (11.1)	12 (12.1)
Subtraction of two or more digits without synthesis or secrets	94	74 (78.8)	10 (10.6)	10 (10.6)
One digit as the multiplier (multiplication)	98	71 (72.4)	14 (14.3)	13 (13.3)
One-to-one correspondence	97	77 (79.4)	9 (9.3)	11 (11.3)
One-digit addition with synthesis or secrets	88	68 (77.3)	11 (12.5)	9 (10.2)
Addition of two or more digits with synthesis or secrets	86	67 (77.9)	10 (11.6)	9 (10.5)
One-digit subtraction with synthesis or secrets	84	64 (76.2)	11 (13.1)	9 (10.7)
One digit as the divisor (division)	82	60 (73.2)	10 (12.2)	12 (14.6)
Subtraction of two or more digits with synthesis or secrets	80	60 (75.0)	11 (13.8)	9 (11.2)
Two or more digits as the multiplier (multiplication)	80	56 (70.0)	12 (15.0)	12 (15.0)
Decimals or money	67	53 (79.1)	8 (11.9)	6 (9.0)
Two or more digits as the divisor (division)	66	46 (69.6)	10 (15.2)	10 (15.2)
Record keeping (such as telephone numbers and score keeping)	48	36 (75.0)	4 (8.3)	8 (16.7)
Fractions	43	32 (74.4)	5 (11.6)	6 (14.0)
How to couple two abaci together to perform more lengthy computational tasks	27	19 (70.4)	3 (11.1)	5 (18.5)
Square roots	11	6 (54.5)	2 (18.2)	3 (27.3)

abilities. A participant who worked with young students echoed the sentiments of many respondents: "I start them when other children begin doing math, i.e., when they enter school!"

The participants who reported teaching abacus skills to students were given the same list of skills found in Rosenblum and colleagues (2013). In this study, the participants were asked to tell the level of proficiency they were expected to achieve and the exposure they received for each identified skill within their university preparation. Using this list and thinking of their students with visual impairments, the participants were asked to indicate which of these skills they teach their students. Data are reported for the skills in Table 1 on the basis of the participants' employment settings. Addition and subtraction were the two math operations most often taught to the students. Higher-level math computation skills, such as multiplication with multiple digits in the multiplier or division, were taught less frequently. Few participants provided instruction on computing fractions or square roots using an abacus.

The participants were also asked to explain the reasons they did not teach certain skills to their students. Seventy-seven answered this open-ended question. Their responses included that they did not believe that they were effective instructors of abacus skills, lacked confidence to teach abacus skills, did not know where to get updated training, did not like using an abacus, or did not have time to teach abacus skills. Other responses were related to the lack of support, including the lack of a paraprofessional to follow up on abacus skills with students. Still other responses were related to the lack of time: "There isn't typically enough time in a regular elementary curriculum to do both the math curriculum well and teach the abacus besides."

The participants listed reasons related to their students as justification for not providing instruction in abacus skills. These reasons included their perceptions that students used mental math; that the abacus was not an appropriate tool for specific students; that students who are infants, toddlers, or preschoolers are not yet ready for instruction in abacus skills; that students have difficulty learning abacus skills; and that students use technology for mathematics. One participant supported the increasing use of technology: "By the time the students have the basic math knowledge to effectively use the abacus, they are using technology that includes calculators."

Resources used by the participants

An open-ended question asked the participants which resources (such as books, websites, and activities) they use when teaching abacus skills to their students. The most commonly used books were *Abacus Basic Competency: A Counting Method* (Millaway, 2001), *Use of the Cranmer Abacus* (Livingston, 1997), and *The Abacus Made Easy* (Davidow, 1988). Several participants reported that they considered the materials they received through the Hadley School for the Blind course on abacus methods to be great resources. The video *Hands-on Experience with the Cranmer Abacus* (Pester, n.d.) was also used, as were instructional videos clips on YouTube (a video-sharing website). Some participants referred to course materials from their university preparation programs. Only a few identified additional resources for activities they use with their students to teach and practice computational skills using an abacus.

Participants who did not provide instruction in an abacus

Of the 196 participants, 32 reported that they did not teach abacus skills to children with visual impairments. These individuals were given a list of reasons why they might not teach abacus skills and were asked to check all that applied. Ten (31.3%) chose "I do not have the knowledge or skills to be an effective abacus instructor for my students"; 10 (31.3%) chose "My students use mental math or rote memorization to complete mathematical computation"; 8 (25.0%) chose "I am no longer confident in my abacus skills because I have not taught abacus in a long time [or]ever"; 8 (25.0%) chose "I work with students who do not have the ability to complete simple addition [and] subtraction using objects, so the abacus is not an appropriate tool"; 7 (21.9%) chose "I don't know where to go to get updated training in abacus skills"; 5 (15.6%) chose "I work with students who are infants, toddlers, . . . or preschoolers who are not yet developmentally ready to use the abacus"; 2 (6.3%) chose "I do not have time to work 1:1 with a student to teach him [or] her the abacus"; and 2 (6.3%) chose "I do not have a paraprofessional or other staff member who can follow through on abacus instruction when I am not with the student." The participants provided additional reasons why they did not provide instruction in the abacus, including that their students had low vision, used technology, and were not developmentally ready for instruction in abacus skills.

The 32 participants were asked, "In the future do you plan to teach the abacus to students who are visually impaired for whom it would be an appropriate tool?" Seventeen (53.1%) said that they were definitely unlikely or unlikely to teach abacus skills, 10 (31.3%) were fairly certain that they would teach abacus skills, and 5 (15.6%) had definite plans to teach abacus skills in the future. The 32 participants were asked to share their level of agreement with the statement, "I believe the abacus is a useful tool to teach students to perform mathematical calculations" on a 4-point Likert scale from 1 = "definitely not likely" to 4 = "definitely likely." The mean for this item for 32 participants was 2.85 (SD = 1.17), the median was 3.00, and the mode was 3.

Discussion

In this age of technology, the abacus is still being used and continues to have a place in the toolbox of students with visual impairments. Rosenblum and Smith (2012) found that computation with an abacus was taught in 25 of 26 university preparation programs. University instructors would not allocate precious time to teach preservice teachers of students with visual impairments to use this device if they did not think it had a place in the toolbox of students. The data gathered in this study are valuable, because they provide the field with a snapshot of how teachers of students with visual impairments decide to teach computation with an abacus, how to determine when instruction should begin, which methods of computation are being taught, and which computational skills students learn with an abacus.

Most U.S. states and Canadian provinces have standards that require students to pass high-stakes tests to advance to the next grade or to graduate. More than one in four participants did not know if an abacus was permitted to be used on high-stakes tests in their state or province. It is imperative that teachers of students with visual impairments be well versed in what is and is not permissible for students to use on these tests. In addition, almost half the participants indicated that their students do not have IEP goals related to using the abacus. When one considers that sighted students are allowed to use scratch paper to compute, children with visual impairments who are abacus users should be allowed to use this tool.

We were surprised to note that not all the participants who indicated that they taught abacus computation skills used an abacus to teach the concept of one-to-one correspondence. It is possible that they use other math manipulatives to teach this skill before they introduce the abacus. Further examination of this aspect of abacus instruction could be valuable. It is not surprising that higher-level math skills (such as division with two-digit divisors or computing fractions and square roots) were taught to few students. It would be valuable to determine if these skills are not taught because teachers of students with visual impairments are not comfortable with these skills, students are not developmentally ready for instruction in these skills, or other tools (such as a calculator) are used.

The role that technology plays in the decision-making processes of both teachers of students with visual impairments and students as to what strategies and tools are used in math instruction and how this technology influences a student's choice to compute with an abacus or other devices, such as a talking calculator, would also be worth further exploration. Both mental math and the use of technology have their place in education. Like all students, students with visual impairments should be expected to be proficient in these skills. Seeley (2005) suggested that there are two major functions of mental math. Traditional means of computation may be considered the primary role, but the extended function of mental math includes conceptual understanding and problem solving. Therefore, we must be cautious in not sacrificing students' understanding of concepts, such as place value and the ability to compute without using technology. The abacus is not a tool that is exclusively replacing technology, but is a device that can complement mental math and technology options for mathematics. A well-balanced instructional program that combines the goals of the general education curriculum and the ECC (Hatlen, 1996) is necessary for students with visual impairments.

It is interesting to observe that the participants did not view the presence of an additional disability as a determining factor in whether to provide instruction in using an abacus. Although a significant number of participants rated academic ability as a determining factor, functional use of the abacus, such as keeping records and organizing data, were not readily identified. We acknowledge that the abacus has distinctive roles for students whose learning needs are more concrete and functional. Approximately one-third of the participants taught record keeping using an abacus. They identified keeping scores during games, tallying the number of items completed, and developing number concepts as ways to use an abacus that should be taught to students.

Limitations

This study had several limitations. First, we did not gather data about specific children to whom abacus instruction was provided, nor did we evaluate the quality of the instruction that the participants provided. Second, all the data we gathered were from self-reports, and we did not verify them. Third, the topic of preparation and instruction in an abacus may have been one that did not interest some potential participants because they do not believe in the value of the tool, do not have experience teaching abacus computation, or for any other unspecified reason. Therefore, these individuals may not have participated in the study, which may have skewed the data gathered from the reported experiences and interest levels of the participants. Fourth, not all the participants responded to all the questions. Finally, the study was advertised on national electronic bulletin boards, and we sent information to teachers of students with visual impairments whom we knew. Thus, this convenience sample may not represent the population of teachers of students with visual impairments in the United States and Canada.

Implications for practitioners

The abacus is used with students who are visually impaired to teach computation. We recognize that the role of teachers of students with visual impairments is multifaceted, as Spungin and Ferrell (2007) described. Teachers of students with visual impairments must be well prepared to meet the diverse needs of their students. Although some participants indicated that they did not teach computation with an abacus to their students because of their own lack of knowledge, other participants reported that this was not the case. Since Rosenblum and Smith (2012) reported that 25 out of 26 university preparation programs provide instruction to future teachers of students with visual impairments in computation with an abacus, a logical conclusion is that the vast majority of future teachers of students with visual impairments should have received instruction in this area. If they have not received such instruction, or if their instruction was so long ago that they are "rusty," resources are available to support their abacus computation skills. These resources include instructional books, videos, and courses from the Hadley School for the Blind. L. Penny Rosenblum, at the University of Arizona, is working on an iDevice app that will allow one to practice abacus computation skills for addition and subtraction using the method developed by Livingston (1997). If she is successful in developing and distributing this app, she plans to add other math operations and computation methods.

Abacus instruction for students who are visually impaired supports the common core state standards that define the knowledge and skills that students should have during their K–12 education. These standards focus on preparation for future educational and vocational goals and include STEM (science, technology, engineering, and math) standards.

Future studies are needed to examine closely how teachers of students with visual impairments are providing instruction to students in using an abacus. Questions to guide this research include these: At what age is it best to introduce the abacus to children? What method of computation is best to use with specific types of learners? Where should abacus instruction be provided (in a general education classroom or in a resource room)? For students who have additional disabilities, what criteria should be used to determine whether an abacus is an appropriate learning tool, and what methods should be used to teach the students to use an abacus in a meaningful way on the basis of their learning needs and future goals? Last, what is the role of an abacus for students who are using both assistive and mainstream technology?

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Sheila Amato, Ed.D., *adjunct professor, Dominican College, 470 Western Highway, Orangeburg, NY 10962; e-mail:* <*sheila.amato@dc.edu*>. ***Sunggye Hong, Ph.D.,*** *associate professor, Special Education Department, San Francisco State University, 1600 Holloway Avenue, San Francisco, CA 94132; e-mail:* <*hong72@sfsu.edu*>. ***L. Penny Rosenblum, Ph.D.,*** *associate professor of practice, Department of Disability and Psychoeducational Studies, University of Arizona, P.O. Box 210069, Tucson, AZ 85721; e-mail:* <*rosenblu@u.arizona.edu*>.

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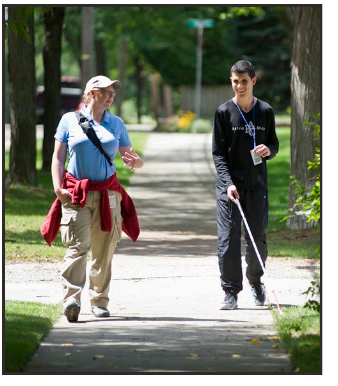
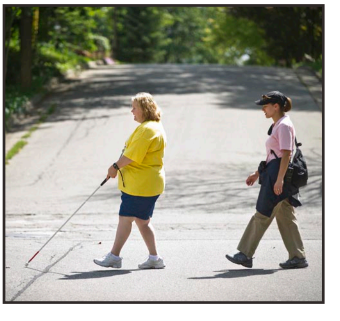
- Because they have reached a milestone (such as age, ability or end of service provision) that makes them ineligible for additional services
- To prepare to receive a Leader Dog



Just like our guide dog program, our AMP training is provided completely free of charge including air travel.



Additional information is available on our website at leaderdog.org/programs or contact us at 888/777.5332 to talk directly with one of our client service representatives.

LEADER DOGS FOR THE BLIND