The Abacus: Teachers' Preparation and Beliefs About Their Abacus Preservice Preparation

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Structured abstract: *Introduction:* This article reports on a study of 196 teachers who shared their experiences and opinions related to how they were taught to use the Cranmer abacus. *Methods:* In February and March 2012, the participants completed an online survey to gather information about their preparation in using and beliefs about computation with the Cranmer abacus. *Results:* The participants resided in both the United States and Canada and had various years of experience. The majority ($n = 112$) reported learning computation with an abacus in their personnel preparation programs. The participants rated their level of agreement with belief statements. Statements with the highest level of agreement included one that indicated that when sighted individuals use pencil and paper for computation, an individual with a visual impairment should be allowed to use an abacus, and another that an abacus is an accessible and inexpensive tool. *Discussion:* The self-report data from 196 participants indicated that computation with an abacus is taught in university programs, although there is variability in what computational skills are taught and what methods are used. There was a higher level of agreement with statements that implied the positive attributes of using an abacus for computation than with those that implied negative attributes (for example, the abacus is obsolete). *Implications for practitioners:* University preparation programs are continuing to teach some level of abacus computation skills to their students. It is not clear if the level of instruction is adequate. Further studies are warranted that examine what pre- and in-service teachers of students with visual impairments are learning and how they are learning in their university preparation programs and through other methods.

In the 1960s, Tim Cranmer based his abacus designed for individuals who are blind on the Japanese soroban. Today the Cranmer abacus (referred to in the remainder of this article as *the abacus)* is manufactured by the American Printing House for the Blind (APH) and can be used by people with visual impairments (that is, those who are blind or have low vision) to compute addition, subtraction, multiplication, division, and more advanced mathematical functions.

There are several computation methods for the abacus that are used in the field of

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visual impairment. The *logic-partner method* focuses on understanding the "what" and "why" of the steps in solving a problem on the abacus. It requires that a student know the "partners" or complements of the numbers up to 10 (5 = 2 + 3 and 5 = 1 + 4). This method uses synthesis when abacus beads cannot be set directly. Verbalizing the steps and the reasons for each movement made on an abacus is an important feature of this approach (Livingston, 1997). The *secrets 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). In the *counting method,* the student counts 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). The *paper-compatible method* has the user complete problems in the same way an individual completes them using paper and pencil. The standard mathematical facts are used, not the secrets or a series of questions (Willoughby & Duffy, 1989). Finally, the Hadley School for the Blind method uses the *indirect method* to teach the abacus. The indirect method combines both the logic-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.

In the first two decades following its inception, studies were conducted to examine the use of the abacus in residential schools for students with visual impairments (Steinbrenner, Becker, & Kalina, 1980) and the way in which university preparation programs were preparing future teachers of students with visual impairments to teach computation with an abacus (Steinbrenner & Becker, 1982). More than 30 years ago, Steinbrenner and Becker (1982) reported that universities were ineffective in their preparation of teachers of students with visual impairments to teach abacus computation to students who are blind.

During the 1990s, no studies on the use of the abacus were published. However, recommendations in the literature during that period continually stated that university personnel preparation programs should teach computation using an abacus to future teachers of students with visual impairments and help practicing teachers update their skills (Rapp & Rapp, 1992). Sakamoto (1999) noted that little attention had been paid to the potential of the abacus in the past several decades. More than a decade has passed since Sakamoto's study, and the abacus continues to be relegated to a few words in articles that discuss mathematics instruction for students who are blind or in articles about the expanded core curriculum. For example, Smith and Kelly (2007) reported that teacher preparation programs teach computation with an abacus at different technology-awareness levels; 27% teach at the "awareness" level, 33% teach at the "proficient" level, and 40% teach at the "advanced" level. Rosenblum and Smith (2012) reported that of 26 university programs, 10 programs instructed students in using an abacus as a primary focus of a course, 13 programs provided instruction in using an abacus as an embedded skill in a course, and 3 programs had students complete their instruction through a correspondence course.

Few studies have been conducted to determine the experiences of teachers of students with visual impairments who have taught or are currently teaching abacus skills to students with visual impairments. The purpose of the study reported here was to gather data that could be used to determine how much emphasis to place on abacus instruction within university teacher training programs. The research was approved by the Institutional Review Board at the University of Arizona. We sought to gather data about how teachers of students with visual impairments in the United States and Canada were prepared to use an abacus, how they determine when to teach abacus computation to their students, what method or methods they use when teaching computation with an abacus, what specific skills they teach to their students, and their attitudes about the effectiveness of the abacus as a tool for use by students who are visually impaired. Data were also gathered from teachers of students with visual impairments who reported that they did not teach abacus computation to students with visual impairments. For the purpose of this article, we acknowledge that mathematics skills, such as setting numbers and counting, while not computational skills, are included in the realm of math skills that are taught using an abacus.

Method

Instrument

The survey instrument was based on questions that surfaced from our work both as individuals who prepare teachers of students with visual impairments and as teachers of students with visual impairments ourselves. The survey gathered demographic data about 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 questions on how they learned to compute using an abacus. Those who responded that they learned through a university preparation program were then asked 11 questions about the method of instruction used and the scope of computational skills taught at their university preparation programs. All the participants were asked if they had previously taught computation with an abacus to children with visual impairments and if they currently did so. Those who answered no to both questions were directed to an online path containing 4 questions that were designed to determine the reason they did not teach abacus computation skills to children. After this group completed these 4 questions, the survey ended for them. Those who indicated that they teach abacus computation to children or did so in the past completed a sequence of questions that examined the method or methods they used to do so, the skills they taught, and their beliefs about using an abacus. This article reports data about the participants' preparation in computation with an abacus and their beliefs about the effectiveness of an abacus as a computational tool. Data on how the participants teach abacus skills to their students and the decision-making process they undergo when determining that the abacus is an appropriate tool to teach to students is described in Amato, Hong, and Rosenblum (2013).

During the development of the survey, we solicited input from four individuals who are knowledgeable about abacus instruction for students who are visually impaired. We used DatStat Illume, an online survey-management and data-collection tool, to create the questionnaire online and to gather the participants' responses. Seven individuals field-tested the online survey, including three who used screen readers, and provided comments related to the accessibility of the online survey. The online survey was available to the participants in February and March 2012.

Recruitment of the participants

The study was advertised on local and national electronic bulletin boards in the field of visual impairment. We also contacted individuals we knew who had completed a university preparation program through one of the universities at which we are currently employed or were employed in the past. After reviewing a letter of invitation and consenting to participate in the study, the individuals were asked "Are you certified or licensed to teach students with visual impairments in your state or province?" Those who answered yes continued with the survey, and those who answered no were directed out of the survey.

Results

A total of 196 individuals completed the online survey about their experiences and beliefs related to instruction using the abacus. This section reports the data gathered from these participants. Not all the participants completed all sections of the survey, and those who did complete a section did not necessarily answer all the questions. Therefore, throughout the article, we indicate the number of participants who answered a specific question.

Demographic data

Of the 191 participants who reported where they resided, 9 were from Canada and 182 were from 1 of 39 U.S. states. Most participants were from California (18 or 9.4%), followed by New York (11 or 5.4%), Virginia (11 or 5.4%), and Arizona (10 or 5.2%). Table 1 presents the demographic data for the 196 participants. The participants were divided into two groups: those who reported that they, in the past or currently, taught children abacus skills (n = 122), and those who do not teach abacus skills to children (n = 64). Since the totals varied on individual items, the numbers in rows do not always add up to the total for the item.

Methods used for the participants to learn abacus skills

The 196 participants were given a list of potential ways in which they could have learned abacus skills and were asked to check as many items as were applicable. The largest number of participants, 112, learned in a university personnel preparation program; 92 learned through self-study; 26 learned from instruction by a colleague; 18 learned through a distance education school, such as the Hadley School for the Blind; and 17 reported that they do not know how to use an abacus. The participants listed additional ways in which they learned the abacus, including from their teachers of students with visual impairments during their own elementary school years as students with visual

Table 1
Demographic data for the 196 participants.

Variable	Total (N = 196)	Participants who teach the abacus (n = 122)	Participants who do not teach the abacus (n = 64)
Gender (n = 194)			
Female	180	114	58
Male	14	8	5
Age range (n = 196)			
Under 30	11	6	4
31 to 40 years	28	18	8
41 to 50 years	51	30	17
Over 50 years	106	68	35
Participant is visually impaired (n = 192)			
Yes	14	8	6
No	178	113	55
Participant uses an abacus for personal use (n = 194)			
Yes	38	24	13
No	156	87	49
Number of years teaching (n = 196)			
First year	5	5	0
2–4 years	23	12	9
5–8 years	38	24	11
9–12 years	28	18	10
13–16 years	23	14	7
17–20 years	19	11	8
21 or more years	60	38	19
Setting in which the participant teaches (n = 194)			
Itinerant	146	99	38
Resource room or self-contained classroom	21	9	11
Residential or specialized school	27	14	13

impairments; through their own participation in adult rehabilitation; through videos on the Internet; and, in one case, from an individual of Asian descent and, in another case, through instruction from a student with a visual impairment.

The 112 participants who reported that they learned to use an abacus in their university preparation program were asked additional questions. They were given a list of methods. More than half the participants selected more than one method that they were taught or exposed to during their university preparation. These data are reported in Table 2. Then the participants were asked to comment on the methods taught in their university preparation program. They commented about specific books that were used and delivery methods (such as online practice or watching a video) in addition to naming methods taught by their instructors. Several participants noted that the method they were taught and the one they currently teach are not the same. For example, one said, "I was taught using the 'secrets'

Table 2
Proficiency or exposure to methods and ratings of belief statements reported by means (standard deviations in parentheses).

Method	Counting	Logic or partner	Secrets	Paper compatible	Hadley School for the Blind
Taught method to proficiency (*N*)	45	38	26	9	8
Prepared to use an abacus for calculation	3.60 (1.10)	3.74 (1.27)	3.46 (1.27)	3.11 (1.62)	4.38 (.75)
Prepared to teach abacus skills	3.68 (1.17)	3.84 (1.26)	3.48 (1.36)	3.32 (1.66)	4.50 (.75)
Exposed to method (*N*)	21	22	24	15	9
My university preparation program adequately prepared me to use an abacus for calculation	3.05 (1.40)	3.32 (1.04)	3.33 (1.31)	2.87 (1.62)	3.44 (1.30)
My university preparation program adequately prepared me to teach abacus skills to a student with a visual impairment	2.98 (1.47)	3.43 (1.15)	3.25 (1.39)	2.93 (1.53)	3.63 (1.41)

method, but in real practice, this is way too complicated for cognitively delayed students, so I taught myself what I think is similar to the 'counting method.'" A number of participants incorporated methods that their university instructors used in teaching them abacus skills into the way they currently teach abacus skills to children. "We were taught to go through each step and to say it out loud. This way, we knew what came next. This has helped me teach the abacus to my students." A small number of participants indicated they were not satisfied with the abacus instruction they received. "I was disappointed in the abacus instruction I received in my university preparation program. The counting method was mentioned, but my instructor could not tell us how it worked, nor could this instructor point us to a source where we could learn it on our own." Others expressed concern that not enough time was spent on abacus instruction. "My abacus training was one day only . . . for an hour. I left feeling more confused than ever. The texts that are out there describing how to teach [or] use the abacus make no sense to me."

On a 5-point Likert-type scale, the participants were asked to respond to two statements whose response options ranged from strongly disagree to strongly agree. Means for the items were calculated with the higher mean indicating the higher level of agreement. First, the participants were asked their level of agreement with the statement, "I learned to use the abacus through a university personnel preparation program." Second they were asked their level of agreement with the statement, "My university preparation program adequately prepared me to use an abacus for calculation." These data are reported in Table 2.

Skills taught in personnel preparation programs

A list of abacus skills was provided to the 112 participants who reported that they learned to compute with an abacus in their university preparation program. For each skill, they indicated if they learned the skill to proficiency, were exposed to the skill, did not receive instruction or exposure to the skill, or did not recall. These data are reported in Table 3. The participants were given an opportunity to comment on the skills they were or were not taught or exposed to. Few participants offered comments, and those who did

Table 3
Skills learned by 112 participants during their personnel preparation program.

Skill (*N*)	Proficiency	Exposure	No exposure or instruction	Do not recall
One-digit addition without synthesis or secrets (*n* = 101)[a]	62	19	9	11
One-digit subtraction without synthesis or secrets (*n* = 102)	61	20	8	13
Addition of two or more digits without synthesis or secrets (*n* = 102)	58	18	11	15
One-to-one correspondence (*n* = 100)	57	23	5	15
One-digit addition with synthesis or secrets (*n* = 101)	57	22	8	14
Subtraction of two or more digits without synthesis or secrets (*n* = 102)	56	22	12	12
Multiplication with one digit as the multiplier (*n* = 101)	56	31	11	3
One-digit subtraction with synthesis or secrets (*n* = 101)	54	25	9	13
Addition of two or more digits with synthesis or secrets (*n* = 101)	51	26	11	13
Division with one digit as the divisor (*n* = 100)	49	30	13	7
Subtraction of two or more digits with synthesis or secrets (*n* = 99)	48	27	14	10
Multiplication of two or more digits as the multiplier (*n* = 101)	41	42	13	5
Division with two or more digits as the divisor (*n* = 101)	36	41	14	10
Decimals or money (*n* = 100)	32	29	29	10
Record keeping (such as telephone number or score keeping) (*n* = 101)	16	30	37	18
Fractions (*n* = 101)	15	26	44	16
How to couple two abaci together to perform more lengthy computation tasks (*n* = 100)	7	28	51	14
Square roots (*n* = 99)	4	13	54	28

[a] *n* = total.

predominately indicated that their university preparation was so long ago that they did not recall or that their university preparation only gave them an opportunity to develop proficiency in simple math skills, rather than more advanced skills (such as division and fractions). Another participant voiced a different perspective: "For beginning students, my university taught me exactly what I needed to know. It is my responsibility as a teacher to continue to provide myself with the continuing education needed to be an effective and knowledgeable teacher." In the comments, several participants stated that their university preparation program taught them how to do computation with the abacus but did not expose them to teaching methods for instructing students in computation with an abacus. Several commented that instruction in teaching methods came through practica and student teaching opportunities. Finally, other participants acknowledged that their university preparation program could not teach them everything they needed to know. As one participant put it, "[We did] not [have] nearly enough work and exposure to the versatility of this valuable tool."

Beliefs of individuals who teach abacus skills

One hundred forty-six participants were provided with statements and asked to share their level of agreement (from strongly disagree to strongly agree) with them. Means were calculated for each item and are reported in Table 4 cross-referenced with the settings in which the participants were employed and the number of years of their teaching experience. Categories for the number of years of teaching experience were collapsed to make visual scanning of the data easier for the reader.

The participants were given an opportunity to comment on any of the statements listed in Table 4. There was great variability among the comments. A few participants stated that the individual disagreed with our use of such terms as *indispensable* in the statement "An abacus is an indispensable tool for math and science instruction." Some comments stressed the necessity of instruction in computation with an abacus for youths: "I believe that the abacus is a critical tool that should be used especially with students who are blind or visually impaired. It is an effective tool that teaches so many basic concepts that are essential for students doing mathematical computation." One participant noted, "I don't think the abacus is 'essential' for every student. I don't think I would describe the abacus as 'fun.' It can be very confusing to learn how to use." There were participants who commented about how the abacus has been a springboard for students' learning, for example, "I have seen my students' interest in math increase with the use of the abacus; of course, they ultimately prefer the calculator!"

Some participants thought that the abacus had its place, but was far from being the only tool. "An abacus isn't enough. It's the place to start for a blind student, to teach problem solving and literate problem-solving skills, but the sooner a student can be introduced to a laptop with a braille display, the better." Similarly, a participant stated, "I think a student needs more than an abacus to 'level the playing field' in an academic math class. There is much more that they do than calculations; [they need] other tactile tools, such as measuring devices, tactile models [or] figures, etc." And finally, a few participants questioned if the abacus has any value in the toolbox of today's students with visual impairments. As one participant noted: "Students who are visually impaired can do math computation in their heads or through rote memorization and do not need to learn the abacus. My student actually does this [computation in the head]." Another person stated, "If we compare [the] use of technology to using an abacus, of course tech[nology] is going to come out [as the] positive answer. The questions should be related more to if the use of [an] abacus is more beneficial in understanding the sequential processes of mathematics."

Discussion

This article has reported data collected from 196 teachers of students with visual impairments about their preparation in using an abacus and their beliefs about the value of an abacus for use by students with visual impairments.

Table 4
Beliefs of participants reported by means (standard deviations in parentheses).

Statement	Setting in which the participant works (n = 145)			Years working as a teacher of students with visual impairments (n = 146)			
	Itinerant (n = 110)	Resource room or self-contained classroom (n = 16)	Residential or specialized school (n = 19)	1–4 years (n = 17)	5–12 years (n = 49)	13–20 years (n = 34)	21 or more years (n = 46)
Whenever a test taker is allowed to use paper and pencil for working calculations, an abacus should be considered an equivalent substitution for a student who is visually impaired.	4.45 (.88)	4.69 (1.01)	4.26 (.81)	4.35 (.86)	4.64 (.63)	4.47 (.86)	4.29 (1.10)
An abacus provides a student who is visually impaired with an easily accessible, portable, inexpensive tool.	4.33 (.83)	4.50 (.82)	4.32 (.48)	4.47 (.51)	4.46 (.65)	4.38 (.70)	4.15 (1.01)
An abacus is analogous to a pencil and scratch paper for sighted individuals.	4.21 (1.00)	4.38 (1.09)	4.16 (.77)	3.82 (1.33)	4.38 (.81)	4.35 (.69)	4.13 (1.14)
An abacus is a vital component of “blindness-specific” tools for a student’s academic toolbox.	4.07 (.97)	4.50 (.89)	3.78 (.73)	4.25 (.86)	4.30 (.76)	4.06 (.81)	3.82 (1.17)
The abacus is a valuable tool for students who are visually impaired.	4.05 (1.31)	3.75 (1.92)	4.32 (.67)	3.53 (1.51)	4.34 (1.12)	4.12 (1.30)	3.93 (1.44)
The abacus is a fun way to teach math to students who are visually impaired and potentially to their sighted peers.	3.97 (.90)	4.00 (1.03)	3.97 (.90)	4.06 (.97)	4.02 (.82)	3.88 (.81)	3.98 (1.04)
IEP goals should guide instruction in an abacus for a student who is visually impaired.	3.90 (1.04)	3.50 (1.41)	3.63 (1.12)	3.94 (.97)	3.90 (1.03)	3.94 (.98)	3.61 (1.26)
An abacus is an indispensable tool for math and science instruction.	3.88 (.95)	4.44 (1.09)	3.89 (.88)	4.00 (.79)	4.10 (.74)	3.97 (.87)	3.76 (1.25)
An abacus levels the playing field for a student who is visually impaired in a classroom of sighted peers.	3.70 (1.04)	4.00 (1.03)	3.44 (.92)	3.71 (1.05)	3.82 (.91)	3.85 (.93)	3.49 (1.20)
An abacus is a fun way to teach math to students who are sighted.	3.58 (.89)	3.94 (1.00)	3.76 (.90)	3.65 (1.17)	3.68 (.77)	3.62 (.78)	3.61 (1.04)
There are more efficient tools (such as a talking calculator, a portable notetaker) than an abacus.	2.71 (1.18)	2.63 (1.31)	3.11 (1.05)	2.59 (1.23)	2.64 (1.10)	2.74 (1.05)	2.96 (1.33)
The time spent teaching an abacus is better spent teaching a student other skills specific to his or her visual impairment (such as braille, assistive technology).	2.13 (.94)	1.94 (1.18)	2.00 (.75)	2.18 (.95)	2.02 (.69)	2.00 (.89)	2.18 (1.21)

(cont.)

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Because of my own perceived lack of expertise in abacus skills, I am not comfortable teaching students who are visually impaired to use an abacus.	2.04 (1.15)	1.44 (.81)	1.79 (1.03)	1.94 (1.24)	2.14 (1.13)	2.03 (1.19)	1.63 (.93)
The abacus is obsolete.	1.78 (1.04)	1.63 (1.20)	1.68 (.82)	1.88 (1.15)	1.62 (.78)	1.76 (1.02)	1.80 (1.22)
Students who are visually impaired can do math computation in their heads or through rote memorization and do not need to learn the abacus.	1.74 (.92)	1.50 (.63)	1.74 (.65)	1.53 (.62)	1.54 (.61)	1.74 (.75)	1.93 (1.14)

Limitations

The data reported in this article are self-report data and were not verified by us. It is possible that individuals who had strong feelings either in favor of or against the abacus took the time to respond to the survey. The survey was advertised via the Internet, so professionals who do not routinely use the Internet may not have seen the advertisement. Each of us shared the announcement about the study with colleagues and past students. Since two of us teach the logic method in our university courses, it is possible that more individuals who learned this method participated in the study because of their association with one of us.

Beliefs of teachers of students with visual impairments

The participants were given a list of belief statements and asked to rate their level of agreement with each statement. As we examined the means for these statements, we noted that there was inconsistency. For example, there was a high rate of disagreement with the statement "The abacus is obsolete." Yet the participants rated the item "The abacus levels the playing field for a student who is visually impaired in a classroom of sighted peers" as fairly neutral. If the abacus is not viewed as being obsolete, would not one of its values be its ability to level the playing field? A future study that incorporates interviews with teachers of students with visual impairments would allow for the probing of the beliefs of these teachers at a level that was not possible in this study, which used a onetime online survey. It is possible that some inconsistencies in the data were a result of the wording of the statements. Thus, interviews with teachers of students with visual impairments would allow for a closer examination of their beliefs.

Implications for practice

The participants in this study reported using a variety of methods for abacus tasks and computations. On the basis of these data, we believe that university personnel preparation programs have an obligation to teach preservice teachers of students with visual impairments a variety of methods of computation using an abacus. In 1982, Steinbrenner and Becker noted that 25 out of the 30 university programs they surveyed indicated an interest in and concern about abacus training. They further noted that a majority of the respondents believed that abacus training should be included in the proposed list of teacher training competencies. Similarly, in 1992, Rapp and Rapp advocated that university personnel preparation programs should not only provide preservice instruction in computation with an abacus but should take an active role in providing in-service instruction to practicing teachers of students with visual impairments. Since time is often limited in personnel preparation programs, if teaching the various methods is not possible, those in personnel preparation should assure that future teachers of students with visual impairments have at least an awareness of the variety of methods and resources to use for self-study.

The data reported here support the concern that some teachers of students with visual impairments were not taught specific computational skills that they may need to teach to students. Therefore, it would be beneficial to have ways in which individuals can refresh their skills or expand their current skills. Online webinars, an electronic bulletin board devoted to abacus skills and instruction, hands-on workshops, and interactive practice tools all have the potential to enrich teachers' knowledge of the abacus. L. Penny Rosenblum, of the University of Arizona, is working on an iAbacus app that can be downloaded to the iPad, iPhone, and other Apple devices that will enable users to practice addition and subtraction using the logic method. It is hoped that if this tool meets with success, it can be expanded to other computation methods and operations for the abacus. Since the participants reported that they often learned abacus computation via self-study or from a colleague, a more systematic method for providing instruction in abacus skills outside university teacher preparation courses is warranted.

We could not agree more with the participant who stated, "I hope prep[aration] improves for abacus training for TVIs and that AER [Association for Education and Rehabilitation of the Blind or Visually Impaired] or other continuing ed[ucation] for TVIs offer classes [or] sessions on improving skills in abacus." In our high-tech world, it is possible that the art of abacus computation could be lost to future generations. The Cranmer abacus is a valuable tool. It should have its place in the toolbox of individuals with visual impairments. To do so, future and current teachers of students with visual impairments need to have high-level abacus computation skills, so their students can gain proficiency with this tool and thus have the choice to use an abacus in their educational, recreational, or vocational tasks.

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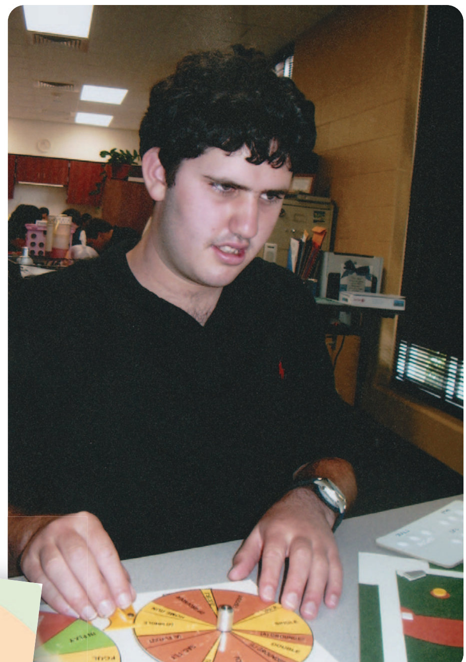
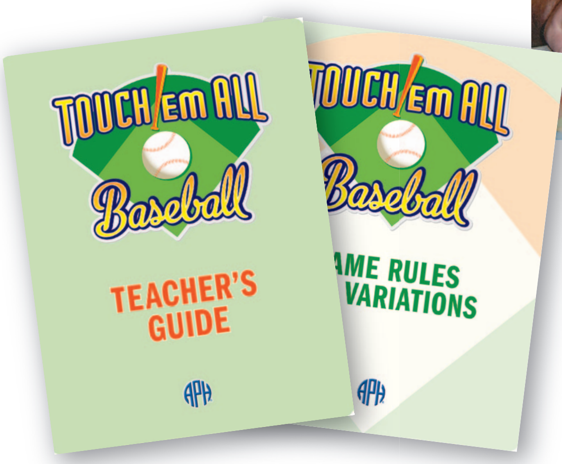


Student playing Touch 'em All Baseball



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