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Error Analysis of Brailled Instructional Materials Produced by Public School Personnel in Texas

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Abstract: In this study, a detailed error analysis was performed to determine if patterns of errors existed in braille transcriptions. The most frequently occurring errors were the insertion of letters or words that were not contained in the original print material; the incorrect usage of the emphasis indicator; and the incorrect formatting of titles, exercises, and directions.

The use of braille transcribers appears to be increasing in the United States. In Allman and Lewis's (1996) study of teachers of students with visual impairments, only 7% of the respondents reported that braille transcribers were available to assist them in preparing materials. In contrast, in a study of slightly more than 50% of the teachers of students with visual impairments in Minnesota, all 51 teachers reported that they had access to a braille transcriber (Knowlton & Berger, 1999). These teachers felt that it was essential for teachers of students with visual impairments to be able to correctly transcribe daily assignments and have the skills to prepare materials to be transcribed by others (Knowlton & Berger, 1999). The essential role of transcribers in preparing materials was echoed in a pilot study on the support provided to 10 high school students who read braille and were enrolled in general education classes. The teachers reported that they used braille transcribers extensively to produce materials for 8 of their students (Leigh & Barclay, 2000). In a more recent study of 107 teachers from 41 states, 37 (35%) reported that a transcriber was available to assist them in preparing materials (Rosenblum & Amato, 2004). Although the increasing reliance on transcribers to produce braille materials has been documented in the literature, it appears that not all teachers of students with visual impairments have access to this critical resource.

The majority of U.S. states do not have a sufficient number of certified braille transcribers and hence use a variety of alternatively trained personnel for transcribing instructional materials in braille for students (Corn & Wall, 2002). Certified transcribers, noncertified transcribers, volunteers, paraeducators, and teachers of students with visual impairments are all regularly used to transcribe materials (Allman & Lewis, 1996; Corn & Wall, 2002; Herzberg & Stough, 2007,

2009; Rosenblum & Amato, 2004; Wall & Corn, 2002). A continued and perhaps even more critical shortage of braille transcribers is anticipated (American Foundation for the Blind, AFB, n.d.; Corn & Wall, 2002). This shortage may lead to students receiving late or improperly transcribed braille materials because not enough competent transcribers are available to produce the materials in a timely fashion.

Sometimes when school personnel, such as aides and paraeducators, are initially assigned to transcribe materials, teachers of students with visual impairments, who may or may not also be certified by the Library of Congress, National Library Service for the Blind and Physically Handicapped (NLS), are assigned to train them (Allman & Lewis, 1996; Curry & Hatlen, 1989). In Texas, training by an itinerant teacher of students with visual impairments is the most commonly used method of training novice braille transcribers (Texas Education Agency, 2000). Although this method has not been evaluated in the literature, its effectiveness obviously may vary greatly in that it is highly dependent on the teacher-trainer's own skills in braille transcribing.

Although most teachers of students with visual impairments value braille as an important instructional medium, the braille-transcribing skills of individual teachers may fluctuate throughout their careers. For example, if a teacher does not use braille for an extended period, his or her braille skills may deteriorate. Amato's (2002) study of teacher preparation programs in the United States and Canada supported this assumption: More than 70% of the 45 teacher-trainers who responded to the survey thought that a teacher's competence in braille transcription was a function of ongoing braille practice. Although refresher braille courses are not required in any state, 42 of the 45 respondents also reported that such courses should be required at regular intervals or when a teacher thought it was necessary to refresh his or her skills (Amato, 2002). Because of the low incidence of braille readers in public schools, teachers of students with visual impairments may have several consecutive years in which they do not teach a student who is a braille reader. Allman and Lewis (1996) found that 51% of the teachers of students with visual impairments in their study were not currently using braille with students at all. Similarly, DeMario and Lian (2000) discovered that 22% of the 205 teachers of students with visual impairments from Illinois and Massachusetts who participated in their study were not currently serving any students who read braille. It follows that the braille skills of these teachers would not be as likely to be maintained as those of teachers who used braille on a daily basis.

If teachers of students with visual impairments will be responsible for transcribing materials intermittently throughout their teaching careers, it is critical that their transcribing skills remain proficient across time. For instance, in Leigh and Barclay's (2000) pilot study of 5 teachers serving students who read braille, the teachers reported that they regularly transcribed some materials themselves. These teachers gave estimates of transcribing that ranged from .5 to 15 hours per week, with an average of 2 hours per week, even though 4 of the 5 respondents had access to a braille transcriber. Similarly, 23 teachers of students with visual impairments in Colorado reported that they

spent an average of almost 10% of their time adapting materials and transcribing materials into braille (Correa-Torres & Howell, 2004).

Brailled instructional materials must be provided in a timely fashion, and in formats that are accurate and legible, in order for students who are visually impaired to learn to read proficiently and perform at their grade levels in reading, math, and science. The timeliness of braille materials is dependent on the general education teacher's advance planning and early submission of the instructional materials that are to be transcribed. In Correa-Torres and Howell's (2004) study, many of the participants reported frustration with general education classroom teachers who changed lesson plans or did not plan far enough in advance so that the materials could be transcribed into braille. The accuracy of braille materials may also vary at the school level, depending on the transcriber's training and expertise. There is no universal standard to determine the quality of braille transcribing, and public schools do not have a standard system for reviewing the quality or readability of brailled instructional materials.

The study presented here was part of a larger project that focused on braille transcribing by public school personnel in Texas (Herzberg & Stough, 2007, 2009). The first part of the project investigated who transcribed instructional materials into braille and how the materials were prepared (Herzberg & Stough, 2007). An electronic survey of 94 school personnel across Texas found that instructional materials were often transcribed by a variety of personnel who were often not certified by NLS. In addition, the majority of respondents thought that their initial training had not adequately prepared them to confidently transcribe materials into braille. It is not surprising that the transcribers and braillists reported that they spent more time each week transcribing materials than did the teachers of students with visual impairments.

In the second part of the project, 40 transcriptions prepared by school personnel were examined. The quality of the transcriptions varied greatly. Slightly more than 10% of the transcriptions contained no errors. The accuracy of the remaining transcriptions ranged from 1–38 errors, with a mean of 14.6 errors. Data supported the hypothesis that students receive brailled instructional materials that are not equal in quality to the materials received by sighted students. The purpose of this third part of the project was to investigate if there were patterns of errors within the transcriptions. The 40 transcriptions prepared by school personnel were reexamined, and a detailed error analysis was performed. Possible errors were divided into eight categories patterned after the NLS scoring categories (Risjord, 2009; Risjord, Wilkinson, & Stark, 2000).

Method

Approval to conduct the research was obtained from the Institutional Review Board at Texas A & M University. The participants were recruited in late fall 2005 through an e-mail message forwarded by personnel of regional service centers at educational centers throughout Texas. Fifty-five volunteers responded to the recruitment e-mail message and were sent a study packet. Eighty percent (n = 44) of the packets were returned. The

overwhelming majority of these participants reported that they were currently responsible for transcribing instructional materials into braille. Only 1 (2.3%) potential participant reported that she spent no time each week doing so. Another participant submitted the questionnaire and a consent form, but no transcription. Data from these two participants were not included in the database or analyzed, since these participants did not meet the criteria for participation. One participant sent the completed transcription on a floppy disk because she did not have access to a braille embosser. I could not open or import the documents, so this transcription was not reviewed for accuracy or included in the database. Thus, 41 transcriptions were initially reviewed by me and a certified proofreader to determine their accuracy. Early in the review process, I discovered that one participant used uncontracted braille on her transcription; thus, 40 transcriptions were used in the analysis of the data.

To simulate how the participants typically transcribed materials for students, I asked them to prepare the worksheet by using specialized equipment, such as a Perkins Brailler; a direct-entry computer program, such as Perky Duck; or braille-translation computer software, such as MegaDots or Braille 2000 (see Table 1 for how the participants prepared the transcriptions). The most commonly used computer-assisted translation program was the Duxbury Braille Translator. In addition, 90% ($n = 36$) of the participants reported that they proofread their transcriptions before they submitted them, and 10% ($n = 4$) reported that they did not proofread their transcriptions.

Table 1
Frequency with which various methods were used to prepare transcriptions.

Method	Frequency	Percentage
Duxbury Braille Translator	18	45.0
MegaDots software	12	30.0
Braille 2000 software	4	10.0
Perkins Brailler	4	10.0
Direct-entry computer program	1	2.5
Combination of a scanner and MegaDots software	1	2.5

Results

Although there is no universally accepted definition of *quality* in relation to braille transcribing, most individuals who transcribe braille would agree that accuracy, the correct application of rules, and formatting are essential characteristics of quality braille. Risjord (2009), the author of the latest NLS braille certification manual, defined accuracy as

> . . . a thorough and exact reproduction of the print text with respect to wording, spelling, punctuation, the correct formation of braille characters, the proper use of contractions, the correct application of all rules of braille transcribing, the proper division of words, and the use of correct braille formats. (p. 20–2).

For example, dots 1, 4, and 5 represent the letter *d* in a word. If an incorrect formation of dots 1, 2, and 4 was used inadvertently, the dots would represent the letter *f*. Depending on the experience of the reader and context clues, this error could cause the word to be read incorrectly or cause confusion for the reader.

The incorrect application of rules also affects the accuracy of braille transcribing.

Depending on how and where a contraction is used, dots 2, 5, and 6 can represent a period, *dd*, *dis*, or the numeral 4 in brailled math materials. According to one of the rules that govern double letter contractions in braille, *dd* can be used only in the middle of words (Ashcroft, Sanford, & Koenig, 2001). If a braille transcriber incorrectly uses the *dd* contraction at the end of a word, such as *Todd*, the braille version would then be read as *To.* Again, this error could easily cause misunderstanding when read by a braille reader.

Accurate and consistent formatting is a third characteristic of quality in braille transcribing. Formatting provides clarity for the reader and allows the braille reader to navigate braille materials easily (National Braille Association, 2002). Furthermore, formatting in braille is highly structured and enables readers to pick out information quickly by scanning the page with their hands (AFB, n.d.). In contrast, inconsistent or incorrect formatting can slow the reader and lead to frustration (Damm & Risjord, 2008; National Braille Association, 2002). Although Risjord (2009) did not formally define formatting in the most recent NLS certification manual, she devoted two chapters and part of four other chapters on how various materials, such as paragraphs, poems, letters, tables, and lists, should be formatted.

Formatting is sometimes a problem for braille transcribers whether they use a braillewriter, a direct-entry computer program, or braille-translation computer software. It is not surprising that transcribers who use braille-translation computer software often spend the majority of their time changing the format of the materials (Sullivan, 2009). Some principles of braille formatting parallel those of print materials, while others do not. For example, the capitalization and punctuation of items in a list would follow the same format as that in print. However, lists that are transcribed into braille are always preceded and followed by a blank line, regardless of whether a blank line would be used in print. In addition, when bullets precede all items in a list in print, the bullets are ignored in braille (Risjord, 2009). Thus, depending on the format of what is being transcribed, materials may or may not follow the same format as the print versions.

Slightly more than 90% ($n = 37$) of the participants who submitted brailled transcriptions rated their transcriptions as "excellent" or "good," and less than 10% ($n = 3$) rated their transcriptions as "fair." However, the participants' perceptions often did not reflect the actual quality of the transcriptions. The actual quality of transcriptions rated as "excellent" or "good" varied greatly, with a range of 0 errors to 38 errors. The only self-assessment that appeared to be accurate was the perception of the 3 participants who rated their transcriptions as "fair." Accuracy scores for these transcriptions were in the bottom quartile and contained an average of 25 errors.

Table 2 presents an overview of the occurrence of errors in the transcriptions. The most frequently occurring error was the insertion of a letter or letters or a word or words into the transcription. For example, several participants added words, such as *got*, *to*, and *has,* to their braille transcriptions that were not in the print copies, and one participant transcribed an additional *e* in the word *them*. Two errors in this category seemed to be especially

Table 2
Number of transcriptions with errors in each category.

Categories of errors	*N*[a]	*X* of errors[b]	*SD*	Range of errors in this category per transcription
Omission or insertion of a letter or word	30	4.4	2.6	1–14
Inconsistent or incorrect formatting	26	7.4	7.0	1–18
Composition signs omitted or used incorrectly	19	1.2	1.5	1–4
Spacing errors or irregularities	18	2.7	3.2	1–15
Punctuation signs omitted or used incorrectly	10	1.0	NA	NA
Misformed characters	6	1.3	0.5	1–2
Contraction errors	6	6.8	8.1	1–21
Detectable erasures	1	2.0	NA	NA

[a] *N* values represent the number of total transcriptions with a certain type of error. For example, 6 of the 40 transcriptions contained a contraction error. Thus, $N = 6$.
[b] *X* of errors represents the mean number of errors related to the category for transcriptions with a certain type of error. The 6 transcriptions containing contraction errors had a mean of 6.8 contraction errors per transcription.

problematic for the participants. Seventy percent ($n = 28$) of the participants added blanks for recording the student's name and date on the transcription, although there was insufficient space for a student to insert this information. In addition, 35% ($n = 14$) of the participants inserted the word *degree* instead of using the proper braille equivalent for the print symbol for degrees.

Sixty-five percent ($n = 26$) of the 40 transcriptions contained formatting errors or irregularities that may have prevented braille readers from easily navigating the materials. The most frequent formatting errors were the incorrect placement of unnumbered, unlettered directions ($n = 23$) in either the first or third braille cell, incorrectly beginning numbered exercises in the third or fifth braille cell ($n = 16$), and incorrectly placing runovers of numbered exercises in the first or fifth braille cell ($n = 21$). Nine participants failed to center the title of the worksheet, and three participants incorrectly indented paragraphs in the second braille cell.

Five composition signs are unique to the braille code. They are dots that are placed before a braille cell to designate a change in the print typeface or to give the following character or letter a special meaning (Risjord, 2009). The transcriptions required the use of three composition signs: the capital indicator, the number indicator, and the italics sign, also known as the emphasis indicator. Nineteen of the 40 transcriptions contained the incorrect usage or omission of a composition sign. Twelve participants (30%) did not italicize the bolded information that students should use to complete sentences when answering each question in the directions. Eight participants (20%) incorrectly italicized the title, and 1 participant (2.5%) italicized a word on the braille transcription that was not italicized or bolded on the print worksheet. One participant did not capitalize a word, and another did not use the number sign before an intended page number.

Eighteen (45%) of the transcriptions contained spacing errors or irregularities. The most frequently occurring spacing

error was incorrectly leaving a space before ($n = 10$) or after ($n = 13$) a dash on the braille transcription as in print. Other spacing irregularities and errors occurred less often. For example, one blank line should have been left between the centered title of the worksheet and the directions. Three participants (7.5%) skipped two lines, and two participants (5%) did not skip a line. Other spacing errors on the transcriptions included no space between two words ($n = 1$), incorrectly leaving a space between the whole-word contractions and the insertion of two spaces between the number and the question in the exercises ($n = 1$), the insertion of two spaces between four sentences ($n = 1$), skipping two lines between the paragraph and the beginning of the numbered exercises ($n = 1$), and failing to skip a line between the paragraph and the beginning of the numbered exercises ($n = 1$).

Ten transcriptions (25%) included a punctuation sign that was omitted, changed, or used incorrectly, and 4 (10%) omitted the dash located within the directions and incorrectly inserted a colon instead. Other punctuation errors were the omission of a period at the end of a sentence ($n = 2$), the omission of a period following a number in the numbered exercises ($n = 1$), the omission of a dash ($n = 1$), the insertion of two commas instead of one ($n = 1$), and the use of a comma instead of a period at the end of a sentence ($n = 1$).

The omission of a letter, word, or sentence may also cause confusion for a braille reader. According to Risjord (2009), an error related to the omission or repetition of text is "undoubtedly the most serious error that can occur because it results in material that is often incomprehensible to the reader" (p. 20–2). Five (12.5%) transcriptions contained the omission of a single letter or word; an additional four (10%) contained two or more omissions. The majority of the errors in this category was the omission of a single word, such as *dry, then*, or *got*. One participant omitted a complete sentence in the text of the first paragraph, while another participant who had used MegaDots omitted nine letters or contractions at the end of lines.

Six (15%) of the 40 transcriptions contained contractions that were omitted or misused. The most frequent such error was the omission of a contraction. For example, three participants failed to use the alphabet contraction *do,* and two others used the part-word sign *th*, instead of the preferred part-word sign *the*, in words like *then, them*, and *clothes*. Whole-word signs were misused less frequently. For example, one participant used the contraction *shall* for *she*, and another used the contraction *that* for *they*. Alphabet signs, lower part-word signs, and lower whole-word signs seemed especially problematic for the six participants who submitted transcriptions with braille contraction errors. The transcriptions of these participants also had a myriad of additional errors, which may suggest that contraction errors are indicative of an overall lack of knowledge of the braille code.

Slightly less than 20% ($n = 7$) of the transcriptions contained detectable erasures or characters that were misformed. Four transcriptions (10%) contained one character that was misformed, and two transcripts (5%) contained two characters that were misformed. No patterns of errors emerged in this category. Some

words that contained misformed characters were *jid* instead of *did*, *thoum* instead of *them*, *filded* instead of *folded,* and *chat* instead of *what*. Only one participant had detectable erasures that could have easily led to misread words.

Discussion

More than 40% of the transcriptions were submitted by teachers of students with visual impairments. As in two previous studies from other states (Correa-Torres & Howell, 2004; Leigh & Barclay, 2000), this finding illustrates that teachers of students with visual impairments are often personally responsible for transcribing the instructional materials that their students need. Because teachers of students with visual impairments often have this responsibility, it is imperative that their preservice training includes instruction in the elements of proper formatting, as well as the literary and Nemeth codes, and that their transcribing skills remain proficient throughout their teaching careers. Currently, some preservice training programs combine both the literary braille and the Nemeth codes into a single university course (Amato, 2002; Rosenblum & Amato, 2004), which may not allow adequate time to teach formatting or the Nemeth code for math and science materials.

In their study on the production of textbooks and instructional materials, Wall and Corn (2002) reported that computers are used in transcribing braille for students with visual impairments across the United States. Similarly, the majority of respondents in all three parts of this project reported that they used computers and braille-translation software at least part of the time when transcribing materials. On the transcriptions, the Duxbury braille translation software was the most commonly used software. The five transcriptions prepared by a Perkins Brailler or a direct-entry program contained an assortment of errors, the number of errors ranging from 18 to 38, with an average of 29. This finding suggests the need for a further investigation of the quality of materials that are prepared with direct-entry methods to determine if other options or technological solutions should be explored or emphasized during training.

Although more than 90% of the participants reported that they proofread their transcriptions, some of the errors, such as misformed characters and the omission of letters and words at the end of a line, could have been avoided or prevented with adequate time and knowledge of braille contractions and proofreading techniques. Two factors could partially explain these errors. Only 15 participants (37%) reported that they had received training in proofreading, and slightly more than two-thirds reported that they knew all the contractions. To address this complex issue, it may be helpful to include how to proofread materials during training and to set minimal universal standards of skills for personnel who are responsible for adapting materials into braille. Personnel who are responsible for transcribing braille should continue to be highly encouraged to proofread materials carefully or to have someone else who is knowledgeable about the braille code and proper formatting proofread the materials.

More than half the transcriptions contained formatting errors. Areas of concern included the formatting of titles, exercises, and directions. One possible explanation for these errors may be that the

participants did not have adequate examples of properly formatted materials or necessary resources. Another possible explanation is that transcribers may be unaware that some principles of braille formatting parallel those of print materials, while others do not. This finding implies that school personnel may be regularly transcribing materials for students that contain formatting and spacing errors. These data also support the need to provide ongoing training for school personnel because with more systematic and advanced training, school personnel will be better equipped to format materials properly.

Although the majority of transcriptions did not contain braille contraction errors, six transcriptions did. Alphabet signs, lower part-word signs, and lower whole-word signs seemed to be especially problematic. The results in this area underscore the findings of Allman and Holbrook (1999). Lower part-word signs and lower whole-word signs are areas that should receive special consideration in training. However, it should also be noted that the transcriptions that contained contraction errors also had many additional errors. Thus, making contraction errors may be indicative of an overall lack of knowledge of the braille code.

Refresher braille courses may be a practical solution when teachers and transcribers need to update or improve their skills. During the 1995–96 school year, the Florida Department of Education designed and presented four regional braille refresher workshops. The rules of braille were discussed throughout the four-day training, and the 58 participants worked on practice exercises that contained the alphabet and the majority of the contractions. An analysis of pretest and posttest data revealed that the teachers improved their braille skills and reported a higher level of confidence in their braille skills (Allman & Holbrook, 1999). States and other entities should consider establishing refresher braille courses or other types of follow-up training as a way of ensuring the proficiency of teachers and transcribers over time.

It continues to be a challenge to produce error-free braille materials whether individuals prepare materials with a direct-entry program or braille-translation computer software (Sullivan, 2009). Quality in braille transcribing truly includes more than just knowing the braille code. Essential characteristics of quality in transcribing include accuracy, the correct application of rules, accurate and consistent formatting, the proper usage of composition signs, and careful proofreading. The results of this investigation suggest that there may be patterns of errors in braille prepared by school personnel and that the skill levels of teachers and transcribers who are responsible for preparing the materials vary greatly. As was suggested previously in the literature (Corn & Wall, 2002; DeMario & Lian, 2000; Rosenblum & Amato, 2004; Wall & Corn, 2002) and by the findings of this study, there is a critical need to standardize training, develop a formal definition of quality in braille transcribing, investigate alternative certifying configurations, establish refresher braille courses, and determine the extent to which students receive brailled instructional materials that are comparable in quality to the materials that sighted students receive.

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