Journal of American Indian Education

Volume 38 Number 1
Fall 1998

# INVESTIGATING THE ADVANTAGES OF CONSTRUCTING MULTIDIGIT NUMERATION UNDERSTANDING THROUGH ONEIDA AND LAKOTA NATIVE LANGUAGES

Judith Towne Hankes, Ph.D.

This study investigated the linguistic structure of Oneida and Lakota language number systems to determine whether the base ten number structure is explicitly communicated in these languages. Two hypotheses grounded the proposal: 1) that the native languages of Oneida and Lakota are more multidigit, base 10, concept specific than English, and 2) that teaching primary grade Oneida and Lakota students in their native language would help them develop better number sense. Study findings suggest that base ten numeracy is more explicit. Further research is needed to determine whether teaching Oneida and Lakota students in their native languages would help them develop better number sense.

## Statement of the Research Problem

The question that focused this study was, Will an investigation of the linguistic structure of Oneida and Lakota language number systems reveal an explicitly communicated base ten number structure? Two hypotheses grounded the proposal: 1) that the native languages of Oneida and Lakota are more multidigit, base 10, concept specific than English, and 2) that teaching primary grade Oneida and Lakota students in their native language would help them develop better number sense.

## Study Motivation and Intention

The proposal of this study is motivated by the fact that American Indians/Alaska Natives have the smallest percentage of secondary and post-secondary students performing at the advanced level of mathematics of all ethnic groups in the United

States (Hillibrandt, Romano, Stang & Charleston, 1992; Lane, 1988; US Department of Education, 1996). It has been suggested that the cause of this inequity is at least in part the way mathematics and science are conceptualized and taught in American schools (AISES, 1995; Bishop, 1988; Grignon, 1991; Nelson -Barber and Estrin, 1995; Oaks, 1990; Secada, 1992; Tharpe and Yamauchi, 1994; Trumbull, et al, 1998). The intention of this paper is not to deliberate on reasons for or resolutions to the American Indian/Alaska Native mathematics problem. Rather, the paper reports a speculative study, which suggests that Lakota and Oneida languages have naming structures that help primary age students develop arithmetic concepts. The study is submitted to encourage scholars and educators with knowledge of American Indian/Native Alaskan languages to examine the intersection of language and numeracy in an effort to improve mathematics instruction and learning.

## A Brief Historical Reflection

> If you spoke Oneida you were punished . . . . I remember sitting in the sewing room . . . only three, four, five years old . . . [If you spoke Oneida] you had to knit. [That sister] cut a heel out of a sock, and she made me mend that sock. Plus, I've been hit with a ruler like this (slapping the back of her hand). She would hit. . . . It was a hardship, really hard. (An 82 year old Oneida elder ; Hankes, 1994)

> They wouldn't let you talk, you know, your own language. . . . There was always somebody there to see if you spoke Oneida, and if they caught you, they made you stand on a stool and watch the others eat. And you only had so much time that you could be in the dining area, twenty minutes at most, and when they got through eating, you marched out too with your plate still there, but you can't touch it. You walk out of there with an empty stomach. (An 86 year old Oneida elder; Hankes, 1998)

The memories described above, though seemingly unrelated to the concept of multidigit numeration, impact directly upon this investigation. Before considering the study topic, it is important to reflect upon how forced assimilation throughout the nineteenth and twentieth centuries influenced American Indian/Alaska Native people. Young children taken from their families, stripped of their customs, forbidden to speak their language, passively withdrew within the hostile environments of Bureau of Indian Affairs boarding schools and missionary domiciles. They never became part of the system. They rejected the ways of the white man's schools and their rejection sustained them, but only partially. They never became what they might have become, powerful keepers of the earth. But today, at the century's end, tribes across the nation have asserted their rights to educate their children and language and culture immersion schools are increasing in number. For this reason, the present investigation into the explicit communication of multidigit numeration of Oneida and Lakota language is timely. It is also a prudent investigation when reflecting on the documentation of mathematics underachievement discussed above.

## Linguistic and Cultural Disadvantages of the English Multidigit Numeration System

The preceding sections documented the limited mathematical proficiency of American Indian/Alaska Natives; however, Americans in general, and for the purposes of this study, American children specifically, demonstrate limited proficiency in foundational concepts of number. The National Assessment of Educational Progress reported: only 64% of third graders could identify the tens place in a four digit number and less than half identified the hundreds or thousands place; a third of the third graders did not correctly complete two-digit subtraction problems requiring a trade and only half did the three-digit problem correctly; and only 72% of the seventh graders correctly gave the number that is 100 more than 498 (Brown et al., 1989; Kouba et al., 1988). In a study completed in the Chicago area, only 69% of the fifth graders solved correctly a three-digit subtraction problem requiring two trades (Stigler, Lee, & Stevenson, 1990). Other studies documented multidigit confusion: many third graders align numbers on the left instead of their positional values when adding and subtracting (Labinowicz, 1985); many third graders identify the 1 traded over to the tens or hundreds column in a regrouping problem as one and not as a ten or a hundred (Labinowicz, 1985; Silvern, 1989);

Fuson (1992) proposes multiple reasons why children in the United States have difficulty constructing concepts of multidigit numeration. One relates to instruction - that most instruction is textbook-driven, and most textbooks present multidigit numeration, addition, and subtraction in ways that interfere with children's ability to make generalizations for developing base ten number sense. Another relates to the fact that there are few opportunities for children in the United States to work with multiunits based on ten, whereas, almost all countries of the world use the metric system. A third reason relates to the linguistic structure of number words. Fuson states that in English number words, value meaning is implicit rather than explicit:

> Translating between written marks and spoken words is complicated by two differences between the marks and words. First, the values of the spoken words are explicitly named, but the values of the marks are implicit within the positions. Thus, children hearing "five hundred sixty-two" want to write the named values "five hundred" and then "sixty" and then "two" (500602) rather than write what looks like “five six two” (562). Second, the position of the written marks do not have absolute values like those in the named value-words, but have only relative values with respect to the rightmost position . . . . English-speaking children, therefore, need to construct and use multiunit conceptual structures that enable them to understand the differing features of both named-value English number words and positional base-ten written marks, and allow them to relate these two symbol systems to each other.

Comparison of English and Asian based number systems reveals that Asian languages explicitly name number values (12 is "ten two", 58 is "five ten eight", etc.) and explicitly state sums and differences to addition and subtraction problems (8 + 4 is "ten two" not "twelve", an English connotation that communicates a unitary cardinal or sequence meaning rather than a base ten quantity). The impact of explicit meaning to application is documented in studies comparing U.S. and Asian performance on base ten assessment. Multidigit items on written and interview tasks given to a large sample of first and fifth graders in the U.S., Japan, and Taiwan indicated considerably lower scores by U.S. children at both grades (Stigler, Lee, & Stevenson, 1990), and Korean second and third graders explained the trading for tens and hundreds better and calculated more accurately than U.S. third graders (Fuson & Kwon, in press; Song & Ginsburg, 1987).

The present study investigated the common linguistic structure of Lakota and Oneida number words to document the explicit communication of base-ten meaning, explicit communication similar to the Asian system described above.

## Investigation Methodology

<u>Qualitative Analysis:</u>

Qualitative research methods scaffolded this study: cultural documents were selected (Appendix A) and culture informants served as consultants, validating accuracy, during the writing process.

<u>Study Objectives:</u>

1. To review and analyze translations of Oneida and Lakota number words to

determine the mathematical structure, and

2. To develop a document that can be used by primary grade teachers of Oneida and Lakota children to be used when reclaiming language and teaching base ten number concepts.

Study Findings: Lakota and Oneida Languages and Explicit Multidigit Number Meaning

Like Asian language, Lakota and Oneida languages describe base ten number quantities explicitly. The following translations reveal this commonality:

**Lakota**

The following number translations were taken from a document developed by Lydia Whirlwind Soldier for the Todd County School District, Mission, South Dakota.

Numbers 1 - 10:

| | |
|---|---|
| wanci - 1 | sakpe - 6 |
| nunpa - 2 | sakowin - 7 |
| yamni - 3 | saglogan - 8 |
| topa - 4 | napcinyunka - 9 |
| zaptan - 5 | wikcemna - 10 |

Counting from 11 - 19

*Wikcemna* (10) is used to represent ten in all other numbers except the numbers between 11 - 19. Within these numbers, the word *ake* indicates that it will be a number between ten and 20 (*ake* stands for 10 +).

| | |
|---|---|
| ake wanji (10 + 1) | ake sakpe (10 + 6) |
| ake nunpa (10 + 2) | ake sakowin (10 + 7) |
| ake yamni (10 + 3) | ake saglogan (10 + 8) |
| ake topa (10 + 4) | ake napciyunka (10 + 9) |

ake zaptan (10 + 5)

Larger Numbers

In all other numbers above 19, *wikcemna* (10) is expressed and stands for ten times (10 x __). Also, in numbers larger than the teens, the word *sam* (pronounced sum) is used as +.

wikcemna nunpa (10 X 2 = 20)

wikcemna nunpa sam wanji (10 X 2 + 1 = 21)

wikcemna yamni sam nunpa (10 X 3 + 2 = 32)

Hundreds

*Opawinge* means hundred times (100 x __):

opawinge wanji sam wanji (100 X 1 + 1) = 101

opawinge wanji sam nunpa (100 X 1 + 2) = 102

opawinge nunpa (100 X 2) = 200

**Oneida**

The following translations were taken from a vocabulary resource developed by Maria Hinton and Amos Christjohn for theOneida Language Project, Oneida, Wisconsin.

Numbers 1 - 10:

| | | | |
|---|---|---|---|
| uskah | - 1 | ya.yahk | - 6 |
| teken | - 2 | tsya.tak | - 7 |
| ahs^ | - 3 | teklu? | - 8 |
| kaye | - 4 | wa.tlu? | - 9 |
| wisk | - 5 | oye.li | - 10 |

Numbers between 11 - 19:

Within these numbers, the *li* ending of the word *oye. li* (10) changes to *le* . The word *yaw^.* is used as plus (+).

| | |
|---|---|
| uskah yaw^. le (1 + 10) | ya.yahk yaw^. Le___ (6 + 10) |
| tekni yaw^. le (2 + 10) | tsya.ak yaw^. le (7 + 10) |
| ahs^ yaw^. le (3 + 10) | teklu? yaw^. le (8 + 10) |
| kaye yaw^. le (4 + 10) | wa.tlu? yaw^. le____ (9 + 10) |
| wisk yaw^ . le (5 + 10) | |

Numbers between 20 - 99

*Wash^* (^ pronounced as uh) is used to represent ten in all number words between 20 - 99. The word *ni* is used to indicate multiplication of tens.

te wash^__________ twenty

| | |
|---|---|
| ahs^ niwash^ (3 x 10) | tsya . tak niwash^ (7 x 10) |
| kaye niwash^ (4 x 10) | teklu? niwash^ (8 x 10) |
| wisk niwash^ (5 x 10) | wa . tlu? tiwash^ (9 x 10) |
| ya . yahk niwash^ (6 x 10) | |

Examples of whole numbers greater than 20 and less than 100, excluding multiples of 10:

kaye niwash^ wisk [(4 x 10) + 5] - 45

wisk niwash^ teken [(5 x 10) + 2] - 52

teklu? Niwash^ wa tlu [(8 x 10) + 9] - 89

Hundreds:

*Tew^nyawe* signifies hundreds; *ok* representing +, examples:

uskah tew^nyawe - 100

tekni tew^nyawe ok tewash tekni [(2 x 100) + (2 x 10) + 2]

## Conclusions and Implications

I t is important to reflect again about forced assimilation and the impact of boarding schools on the quantitative performance American Indian/Alaska Native people. Before Columbus, Lakota and Oneida Indians were adding, subtracting, and multiplying numbers within a base ten system. During the assimilation years, not only was the language of number lost for most Lakota and Oneida people, it was replaced with a system that poorly communicated base ten meaning. Today, in Lakota and Oneida language immersion classrooms, opportunities are being created for students to once again benefit from language explicit communication of base ten concepts.

The information reported in this study has been transferred to curriculum (Appendices A and B). However, use of this curriculum needs to be researched. Furthermore, as stated earlier, a primary purpose for reporting this study is to challenge scholars with knowledge of American Indian/Alaska Native languages to examine the extent to which those languages communicate numeracy characteristics described in this paper.

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## Appendix A

**Lakota Language: Introduction to Lakota Math**

## Appendix B

**The three Sisters Math Book**