

Navaho Linguistics for Quantum Hardware Education

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This document is written by Onri Jay Benally, an Indigenous American born and raised on the Navaho tribe (Diné Bikeyah). Its purpose is to develop and collect Navaho terms associated with quantum information science and technology (QIST), highlighting on quantum hardware engineering. As you may find, this development is motivated by the drive not only to exploit linguistics as a way of better understanding emerging technology, but to also serve as a tool to contribute to the quantum community at large. With that, it may be possible to form a model around this effort in order to break down barriers to entry when it comes to approaching or incorporating oneself into the field of QIST.

If you are interested in learning Navaho, the first section of this document will cover some basic ideas about the language. This will be followed by some examples of how one might think about names and labels from the Indigenous American perspective. It may be worth noting that although Navaho is considered to be a Tier 5 or Category 5 language in terms of difficulty for native English speakers, practicality is our main concern.

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Towards Using Linguistics for Quantum Hardware Comprehension

The Navaho language is highly descriptive, has a heavy presence of verb usage, and is rich in consonant clusters and tonality. It is important to note that the many biomes and topographical differences found on the tribal lands are contributing factors to the various Navaho dialects. This is especially true for the mountainous regions, where pronunciation and modern spelling can vary in a slight manner.

As you may or may not know, the Navaho language was only practiced through oral expression for thousands of years in what is now called North America. Not until relatively recent history did Navaho linguists and language experts decide to pick a written form that could adopt Navaho phonetics. So far, the Latin script (commonly used to write English alphabets) has been the default for writing since then. There are other scripts or writing systems such as Cyrillic (commonly used to write Slavic alphabets, including Russian) that can express Navaho phonetics as well, however it is not actively taught or practiced in the tribe. Either way, the spelling of words are expected to be pronounced phonetically.

For example, it is generally known that Diné has two English spellings: Navaho and Navajo (both pronounced the same). The letter (j), used in the word Navajo, is exclusive to the spelling of the word. If one observes (j) in any other Diné word, then it should be pronounced the same as the English letter (j) or its linearized form (dzh). Keep this in mind.

Virtually all English nouns and subjects can be translated into Navaho based on the depth of understanding and functionality of the word. Thus, when a new English term is coined or invented, a Navaho description can be given and verified by sharing it with another Navaho speaker who should understand what one is saying with context.

In the era of rapidly advancing science, technology, and art, one can express new Navaho terms by simply spending some time to consider the semantics, followed by documenting or producing a shareable form of the new term. Such is the case for topics like quantum mechanics and quantum engineering, provided as examples in this repository. Over time, this documentation is expected to retain a fair amount of content for driving explanations of advanced and technical topics of today (especially quantum), in Navaho.

Towards a Model for Learning & Using Navaho for Quantum Education

- Find the root word.
- How does it behave?
- What is the historical relation or etymology?
- What is the suffix?
- What is the prefix?
- What are the particles, if any?
- What are the potential postpositions?
- Acknowledge that order doesn't matter that much inside the suffixes & prefixes. Also acknowledge that postpositions are used instead of prepositions.

Language Ideas for Quantum Hardware Comprehension

| | English Term | Navaho Term |
|---------------|--------------|--|
| Initial Idea | Some Word | Nv = Eng Nv = Eng Nv = Eng |
| Final Version | Final Word | Navaho Term Spelled = [Rough Transcription] |

Figure 1: Generic blueprint for language breakdown from English to Navaho.

From idea to practice...

| | English Term | Navaho Term |
|---------------|--------------|---|
| Initial Idea | Computer | Béesh = Metal Łichíí' = Red Nitsékees = Think |
| Final Version | Computer | Béesh Łichíí' Nitsékeesí = [A piece of copper that thinks] |

Figure 2: *Computer* in Navaho.

Other examples:

The quick brown fox = Ma'ii dibélchíí tsjįłgo or Ma'ii yishtłizh tsjįłgo

Lazy dog = léechaa'í ilhóyéé

Jumped = nahacha or dah nahacha or dahnáníjįh

To jump = dahnáníshjįh

Jumping = dah nahácha'go

Laziness = ilhóyéé

Slow or in vain = chééh

The quick brown fox jumped over the lazy dog = Ma'ii dibélchíí tsjįłgo léechaa'í ilhóyéé dahnáníjįh

Language Ideas for Quantum Hardware Comprehension

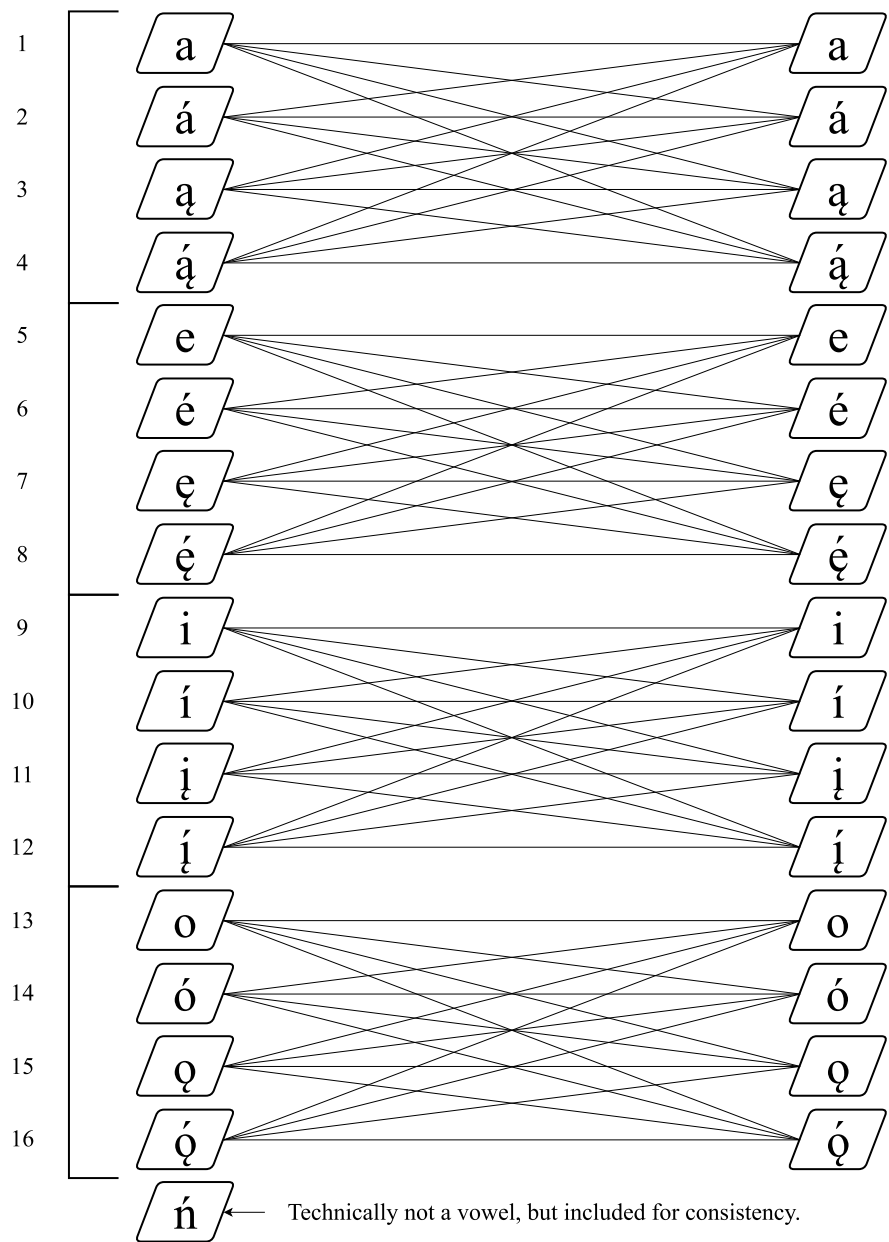


Figure 3: Navaho long vowel network by Onri Jay Benally

| Navaho Character | [UTF-8] "U+" Notation | [UTF-8] "\u" Notation |
|------------------|-----------------------------|--------------------------|
| A | U+0041 | \u0041 |
| B | U+0042 | \u0042 |
| Ch | U+0043 U+0068 | \u0043\u0068 |
| Ch' | U+0043 U+0068 U+0027 | \u0043\u0068\u0027 |
| D | U+0044 | \u0044 |
| Dl | U+0044 U+006C | \u0044\u006C |
| Dz | U+0044 U+007A | \u0044\u007A |
| E | U+0045 | \u0045 |
| G | U+0047 | \u0047 |
| Gh | U+0047 U+0068 | \u0047\u0068 |
| H | U+0048 | \u0048 |
| Hw | U+0048 U+0077 | \u0048\u0077 |
| I | U+0049 | \u0049 |
| J | U+004A | \u004A |
| K | U+004B | \u004B |
| K' | U+004B U+0027 | \u004B\u0027 |
| Kw | U+004B U+0077 | \u004B\u0077 |
| L | U+004C | \u004C |
| L̄ | U+0141 | \u0141 |
| M | U+004D | \u004D |
| N | U+004E | \u004E |
| O | U+004F | \u004F |
| S | U+0053 | \u0053 |
| Sh | U+0053 U+0068 | \u0053\u0068 |
| T | U+0054 | \u0054 |
| T' | U+0054 U+0027 | \u0054\u0027 |
| Tł | U+0054 U+0142 | \u0054\u0142 |
| Tł' | U+0054 U+0142 U+0027 | \u0054\u0142\u0027 |
| Ts | U+0054 U+0073 | \u0054\u0073 |
| Ts' | U+0054 U+0073 U+0027 | \u0054\u0073\u0027 |
| W | U+0057 | \u0057 |
| X | U+0058 | \u0058 |
| Y | U+0059 | \u0059 |
| Z | U+005A | \u005A |
| aa | U+0061 U+0061 | \u0061\u0061 |
| á | U+00E1 | \u00E1 |
| áá | U+00E1 U+00E1 | \u00E1\u00E1 |
| ą | U+0105 | \u0105 |
| ąą | U+0105 U+0105 | \u0105\u0105 |
| ą̄ | U+0105 U+0301 | \u0105\u0301 |
| ąą̄ | U+0105 U+0301 U+0105 U+0301 | \u0105\u0301\u0105\u0301 |
| aaá | U+0061 U+00E1 | \u0061\u00E1 |
| aaą | U+0061 U+0105 | \u0061\u0105 |

| | | |
|----|-----------------------------|--------------------------|
| aa | U+0061 U+0105 U+0301 | \u0061\u0105\u0301 |
| áa | U+00E1 U+0061 | \u00E1\u0061 |
| áa | U+00E1 U+0105 | \u00E1\u0105 |
| áa | U+00E1 U+0105 U+0301 | \u00E1\u0105\u0301 |
| aa | U+0105 U+0061 | \u0105\u0061 |
| aa | U+0105 U+00E1 | \u0105\u00E1 |
| aa | U+0105 U+0105 U+0301 | \u0105\u0105\u0301 |
| aa | U+0105 U+0301 U+0061 | \u0105\u0301\u0061 |
| aa | U+0105 U+0301 U+00E1 | \u0105\u0301\u00E1 |
| aa | U+0105 U+0301 U+0105 | \u0105\u0301\u0105 |
| ee | U+0065 U+0065 | \u0065\u0065 |
| é | U+00E9 | \u00E9 |
| ée | U+00E9 U+00E9 | \u00E9\u00E9 |
| e | U+0119 | \u0119 |
| ee | U+0119 U+0119 | \u0119\u0119 |
| e | U+0119 U+0301 | \u0119\u0301 |
| ee | U+0119 U+0301 U+0119 U+0301 | \u0119\u0301\u0119\u0301 |
| ee | U+0065 U+00E9 | \u0065\u00E9 |
| ee | U+0065 U+0119 | \u0065\u0119 |
| ee | U+0065 U+0119 U+0301 | \u0065\u0119\u0301 |
| ée | U+00E9 U+0065 | \u00E9\u0065 |
| ée | U+00E9 U+0119 | \u00E9\u0119 |
| ée | U+00E9 U+0119 U+0301 | \u00E9\u0119\u0301 |
| ee | U+0119 U+0065 | \u0119\u0065 |
| ee | U+0119 U+00E9 | \u0119\u00E9 |
| ee | U+0119 U+0119 U+0301 | \u0119\u0119\u0301 |
| ee | U+0119 U+0301 U+0065 | \u0119\u0301\u0065 |
| ee | U+0119 U+0301 U+0119 | \u0119\u0301\u0119 |
| ee | U+0119 U+0301 U+00E9 | \u0119\u0301\u00E9 |
| ii | U+0069 U+0069 | \u0069\u0069 |
| í | U+00ED | \u00ED |
| íí | U+00ED U+00ED | \u00ED\u00ED |
| ı | U+012F | \u012F |
| ıı | U+012F U+012F | \u012F\u012F |
| ı | U+012F U+0301 | \u012F\u0301 |
| ıı | U+012F U+0301 U+012F U+0301 | \u012F\u0301\u012F\u0301 |
| ıı | U+0069 U+00ED | \u0069\u00ED |
| ıı | U+0069 U+012F | \u0069\u012F |
| ıı | U+0069 U+012F U+0301 | \u0069\u012F\u0301 |
| ıı | U+00ED U+0069 | \u00ED\u0069 |
| ıı | U+00ED U+012F | \u00ED\u012F |
| ıı | U+00ED U+012F U+0301 | \u00ED\u012F\u0301 |
| ıı | U+012F U+0069 | \u012F\u0069 |
| ıı | U+012F U+00ED | \u012F\u00ED |

| | | |
|----|-----------------------------|--------------------------|
| ĵĵ | U+012F U+012F U+0301 | \u012F\u012F\u0301 |
| ĵi | U+012F U+0301 U+0069 | \u012F\u0301\u0069 |
| ĵí | U+012F U+0301 U+00ED | \u012F\u0301\u00ED |
| ĵĵ | U+012F U+0301 U+012F | \u012F\u0301\u012F |
| oo | U+006F U+006F | \u006F\u006F |
| ó | U+00F3 | \u00F3 |
| óó | U+00F3 U+00F3 | \u00F3\u00F3 |
| o | U+01EB | \u01EB |
| oo | U+01EB U+01EB | \u01EB\u01EB |
| o | U+01EB U+0301 | \u01EB\u0301 |
| oo | U+01EB U+0301 U+01EB U+0301 | \u01EB\u0301\u01EB\u0301 |
| oo | U+006F U+00F3 | \u006F\u00F3 |
| oo | U+006F U+01EB | \u006F\u00EB |
| oo | U+006F U+01EB U+0301 | \u006F\u01EB\u0301 |
| óo | U+00F3 U+006F | \u00F3\u006F |
| óo | U+00F3 U+01EB | \u00F3\u01EB |
| óo | U+00F3 U+01EB U+0301 | \u00F3\u01EB\u0301 |
| oo | U+01EB U+006F | \u01EB\u006F |
| oo | U+01EB U+00F3 | \u01EB\u00F3 |
| oo | U+01EB U+01EB U+0301 | \u01EB\u01EB\u0301 |
| oo | U+01EB U+0301 U+006F | \u01EB\u0301\u006F |
| oo | U+01EB U+0301 U+01EB | \u01EB\u0301\u01EB |
| oo | U+01EB U+0301 U+00F3 | \u01EB\u0301\u00F3 |
| ń | U+0144 | \u0144 |