

# Navaho Linguistics for Quantum Hardware Education

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December 2023

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

Step #	What To Do
1	Find the root word.
2	How does it behave?
3	What is the historical relation or etymology?
4	What is the suffix?
5	What is the prefix?
6	What are the particles, if any?
7	What are the potential postpositions?
8	Acknowledge that order doesn't matter that much inside the suffixes & prefixes.
9	Acknowledge that postpositions are used instead of prepositions.

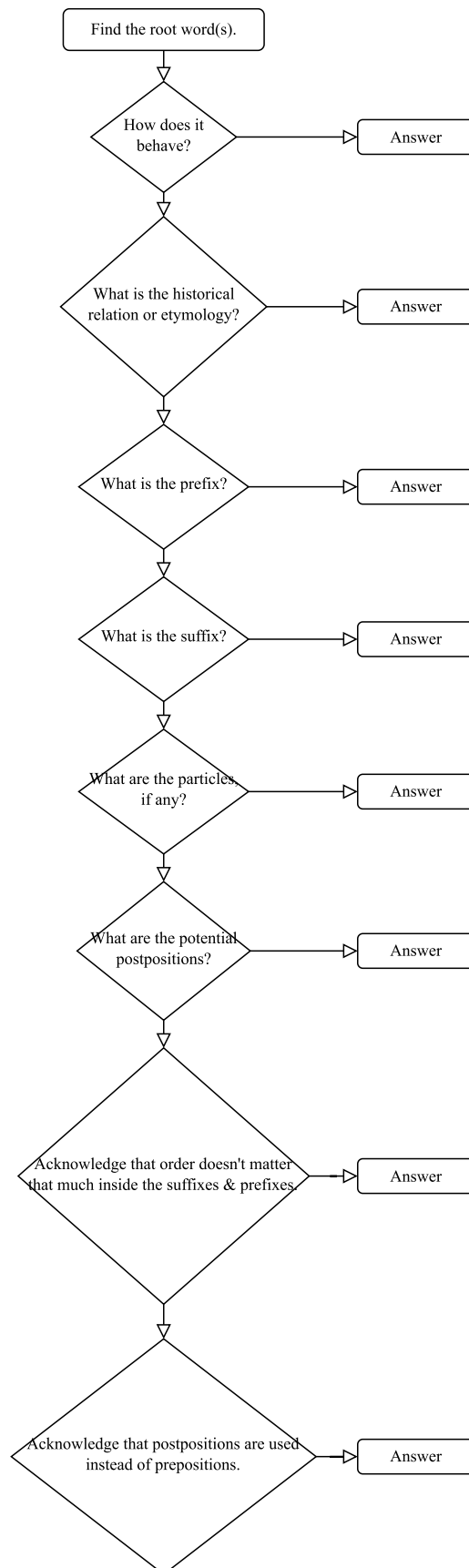


Figure 1: Onri's Translation Model-Flowchart

## 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 2: Generic blueprint for language breakdown from English to Navajo.

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 3: Representation of *Computer* in Navajo.

Other examples:

English	Navajo
The quick brown fox	ma'ii dibéłchíí dilwo' or ma'ii yishtłizh dilwo'
Lazy dog	léechaą'í ilhóyéé
Jumped	nahacha or dah nahacha or dahnáníjįh
To jump	dahnáníshjįh
Jumping	dah nahácha'go
Laziness	ilhóyéé
Slow or in vain	chééh
Fast runner (quick)	dilwo'
The quick brown fox jumped over the lazy dog	ma'ii dibéłchíí dilwo' eii léechaą'í ilhóyéé dahnáníjįh

# Language Ideas for Quantum Hardware Comprehension

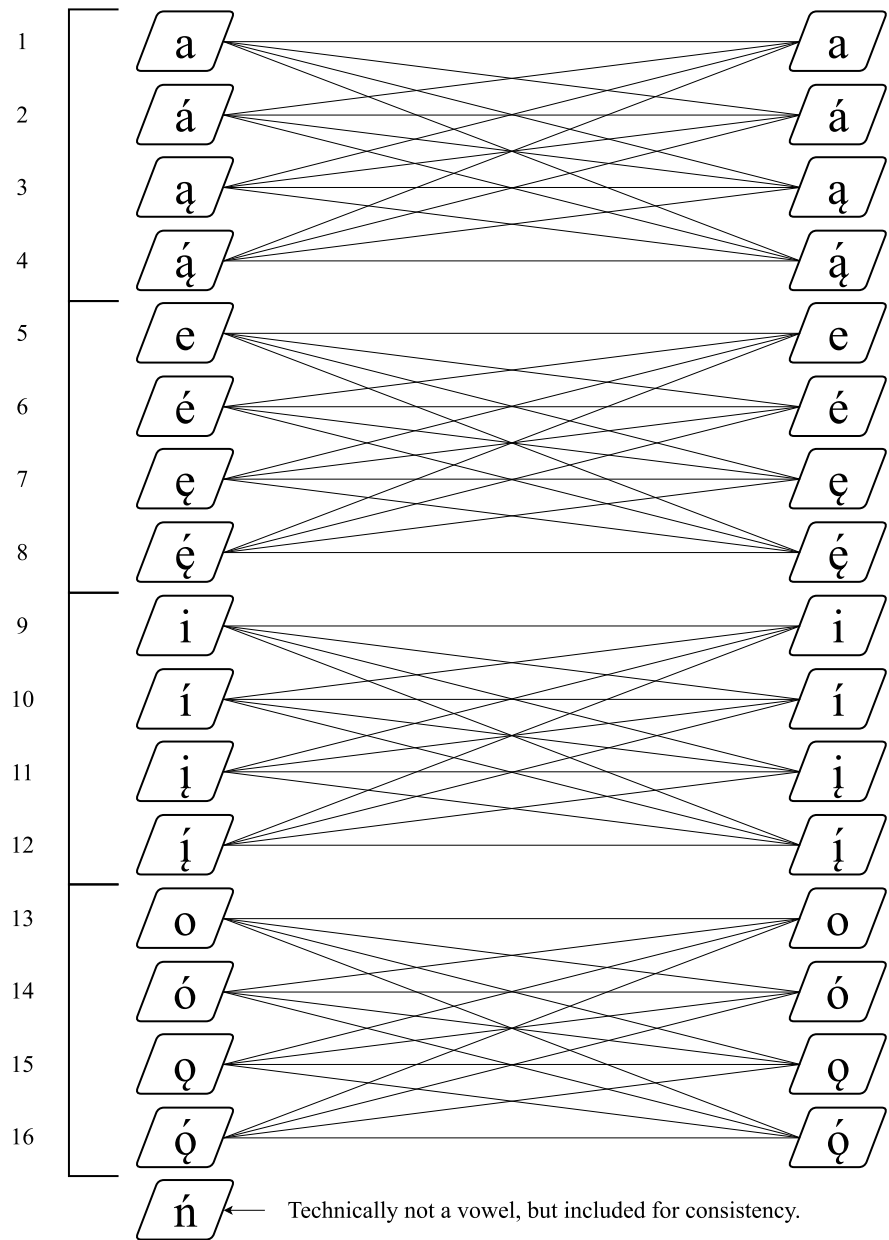


Figure 4: Navaho long vowel network by Onri Jay Benally

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
Ḷ	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
ą	U+0105 U+0301	\u0105\u0301
ąą	U+0105 U+0301 U+0105 U+0301	\u0105\u0301\u0105\u0301
aá	U+0061 U+00E1	\u0061\u00E1
aạ	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
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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
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ıı	U+0069 U+00ED	\u0069\u00ED
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ıı	U+0069 U+012F U+0301	\u0069\u012F\u0301
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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
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