

The need for a standard for the mathematical pronunciation of the natural numbers. Suggested principles of design. Implementation for English, German, French, Dutch and Danish

Thomas Colignatus

<http://thomascool.eu>

September 2-9, 2015 & May 14 2018 (amendment on ampersand)

DOI 10.5281/zenodo.774866

Abstract

Current English for 14 is *fourteen* but mathematically it is *ten & four*. Research on number sense, counting, arithmetic and the predictive value for later mathematical abilities tends to be methodologically invalid when it doesn't measure true number sense that can develop when the numbers are pronounced in mathematical proper fashion. Researchers can correct by including proper names in the research design, but this involves some choices, and when each research design adopts a different scheme, also differently across languages, then results become incomparable. A standard would be useful, both ISO for general principles and national implementations. Research may not have the time to wait for such (inter-) national consensus. This article suggests principles of design and implementations for said languages. This can support the awareness about the need for a process towards ISO and national consensus, and in the mean time provides a baseline for research.

Keywords number sense, counting, arithmetic, mathematical ability, invalidity, design, standards, language, pronunciation, metastudy, number processing, numerical development, inversion effects, language-moderated effects, Google Translate

MeSH Terms Child, Child Development, Educational Measurement, Humans, Intelligence, Longitudinal Studies, Mathematics/education, Mathematics/methods, Mental Processes, Students

American Mathematical Society: MSC2010
00A35 Methodology and didactics
97F02 Arithmetic, number theory ; Research exposition

Journal of Economic Literature: JEL
P16 Political economy
I20 General education

Introduction	2
The need for a standard	2
Principles of design	4
Amendment May 14 2018	5
Implementation	6
Conclusions	6
Appendix: Proposed implementations	7
English	7
German	9
French	11
Dutch	14
Danish	16
References	18

Introduction

First, there is the distinction between (1) a mathematical pronunciation of the natural numbers (0, 1, 2, 3, ...) and (2) the pronunciation of the natural numbers in the natural languages (English, German, ..., French). While we will use the term "natural language" those languages clearly have been subjected to changes by committees or influential authors. Thus the present discussion on a standard on mathematical pronunciation is no breach upon nature.

Subsequently we observe that the distinction between (1) and (2) hinders research on number sense, counting and arithmetic, and their predictive value for later mathematical competence. Research methods may suffer from methodological invalidity when they mistake "number sense in natural language" for "true number sense with mathematical pronunciation". Researchers can try to correct by providing pupils with mathematical names, as Ejersbo & Misfeldt (2015) do. There is a risk that researchers implement their own interpretation of what mathematical names are, so that comparison of results becomes more and more difficult or impossible. Hence, a standard for such mathematical pronunciation will be useful, for achieving both validity and comparability.

For such a standard, we first establish the need, then propose principles of design, and then implement those principles to generate proposals for English, German, French, Dutch and Danish. It must be hoped that there will be a process towards consensus on such standards, both in ISO manner and national implementation. This article hopes to generate interest for such a process. In the mean time, researchers who are already in need of a baseline might be helped by the present suggestions.

The present issue differs principally from spelling reform. The spelling of a number ("29"), remains the same. Only its pronunciation changes. The new pronunciation will be spelled in common fashion too. This issue is not about spelling but about bilingualism and mathematical ability. A discussion in the media is by Shellenbarger (2014) in the WSJ.

The need for a standard

Professor Fred Schuh of TU Delft in 1943 observed that the Dutch pronunciation of the numbers was awkward. While English has *twenty-seven* in the order of written 27, Dutch has *zeven-en-twintig*. He again discussed this in Schuh (1949) and formulated a proposal for change, focussing on the numbers above 20. The proposal reached the Dutch minister of education, see Stoffels (1952), but it was not adopted.

Researchers in Norway had observed the same problem, and the Norse parliament (Storting) adopted a change in 1950, which we see reflected in the pronunciation after 1951.¹ I am not aware of an evaluation report.² Pixner et al. (2011) observe that the Czech language allows both kinds of pronunciation, and they show that the mathematical order causes less errors than the inverted order.

Various authors look into number sense, counting and arithmetic, in which there is an interplay of language, embodiment (fingers), nonsymbolic forms (e.g. dots), symbols (Indian-Arabic numbers), and working memory. Dowker & Roberts (2015) and Mark & Dowker (2015) compare English, Welsh and Cantonese. Zuber et al. (2009), Moeller et al (2011), Klein et al. (2013) indicate that inversion in German slows down the learning progress w.r.t. mathematics proper. In Holland, Friso - Van den Bos (2014), Xenidou-Dervou (2015) and Xenidou-Dervou et al. (2015) indicate the same for Dutch.

¹ <http://blogs.transparent.com/norwegian/learning-norwegian-numbers/>

² I have asked this question at <http://www.matematikkcenteret.no/>

Hopefully this research generates interest amongst policy makers to adopt changes like in Norway 1950/51. However, such changes may still be limited w.r.t. a full mathematical pronunciation. Also English isn't perfect. It would be better to have ten & one for 11 and two-ten & one for 21. Thus the challenge is larger, also for English and Norse.

Studies that compare the performances in languages suffer from the problem that they may study the obvious. Schuh (1949) didn't need modern statistics to arrive at the logical conclusion that number-names are better pronounced as they are written. The real problem lies in the policy making process, see Colignatus (2015ab).

The research on the development of number sense tends to suffer from methodological invalidity. In truth, number sense is defined with the use of mathematical pronunciation. The reason for this is that numbers themselves are defined as such. A natural language tends to be a dialect of the mathematical pronunciation. One should not take a dialect as the norm. Studies that do not allow children to develop number sense by using the mathematical names, will not observe true number sense, but "number sense in natural language". It may be admitted that one can develop statistical measures on such observations, but such a result is an awkward construct of both true number sense and confusion in language, in unclear mixture, without scientific relevance.³

The research on the development of number sense will also benefit from when researchers have deeper roots in mathematics education research (MER). The research quoted above derives mainly from the realm of (neuro-) psychology, and the problems on relevance, validity and comparability might have been observed at an earlier stage when there had been more awareness about what it actually is that pupils must learn. For a mathematician as Fred Schuh the pronunciation *zeven-en-twintig* is obviously illogical, while a neuro-psychologist may record it statistically as an "inversion", and actually think that this is how numbers are pronounced also mathematically, given that mathematicians also use such names. When (neuro-) psychologists would look deeper into MER, they must be warned that this field is not without problems of its own, however. See Colignatus (2015ab) for a longer discussion.

Relevant for research is the question whether pupils can deal with the difference between mathematical names and natural language dialect names. We see that many children can manage, see the examples of Czech, bilingual Chinese, bilingual English & X (e.g. in Holland), and in Ejersbo & Misfeldt (2015). The problem is not with children but in the policy making process, see Colignatus (2015a).

Thus, researchers interested in number sense, validity and relevance, will tend to follow the example by Ejersbo & Misfeldt (2015) and include in the research design an instruction for pupils for using mathematical names. Perhaps researchers can find schools that are willing to participate in experiments with dual names, given that these aren't really much of experiments since we know that most children can deal with it. When parents are properly informed and first receive a training in the mathematical names, they might readily sign consent forms.

Colignatus (2015a) contains a chapter *Marcus learns counting and arithmetic with ten*. This text contains a stylized presentation for six-year olds. This is not intended for actual use in class but contains the framework for starting to think about that. There are translations for German, French, Danish and Dutch, that is: at this moment of writing the text still is in English but the numbers have been replaced by those in the **Appendix** below. This can also be used to instruct parents.

The real bottleneck then becomes comparability of research results. There are still questions of design. Different researchers might use different rules, and thus we would lose comparability. This establishes the need for a standard.

³ See also my weblog text <https://boycottholland.wordpress.com/2015/08/29/research-on-number-sense-tends-to-be-invalid/>

Principles of design

It is easy to suggest a "mathematical pronunciation of numbers in German", but what would that be? When we use current *zehn* for 10, then there arises a problem, since the present pronunciation of 19 could be the mathematical pronunciation of 90. This will generate great confusion, and Germans would have to check continuously whether others are using current or mathematical names. However, German might replace *zehn* by *zig* or adopt English *ten* or scientific *deca* (though two syllables).

Number	Math in English	English	Math in German ?	German	Math in German !
19	ten & nine	nineteen	zehn & neun	neunzehn	zig & neun
90	nine·ten	ninety	neun·zehn	neunzig	neun·zig

The proposed principles of design are:

- (1) Pronunciation fully follows the place value system ... $c \times \text{hundred} + b \times \text{ten} + a = \dots cba$. The current convention to start with the digit with the highest place value is fine. (See Colignatus (2015a) for lesser alternatives in pronunciation and order.) Much of arithmetic can be done by proper pronunciation (e.g. $2 \times 10 + 4 = 24$).
- (2) In writing out the pronunciation, also in educational texts, the middle dot is preferred over the hyphen since the latter may be confused with the minus-sign. ⁴ We thus say *five·ten* & *nine* for 59, where the dot is not pronounced and the order helps to decode the position (e.g. we don't have to say that 9 has place value one).
- (3) There is awareness of the distinction between the process of calculation and the result given by the number. The process would be *two times ten plus four* and the result would be *two·ten* & *four*. On occasion *two of ten and four* might have the double role of both process and result. Operators might be bracketed or coloured to indicate that they are not pronounced, as in *two (times) ten (plus) four*. It must be tested whether young children would be served by a phase in which those operators are still pronounced also for the number result. Also elder pupils might at occasion be reminded of it. Also other names than times must be researched (e.g. the verb *to of*). Plus and minus however would be universal (given that "and" might not be commutative, as in *he missed the train and arrived late at work*).
- (4) There are no exceptions in pronunciation of the digits in different place value positions. For example, German currently uses *sieben* in 7 and 27 and *sieb* in 70. A choice must be made for one name only. As a rule the shortest name is selected. For English some authors use *tens* as in *two·tens* & *one*, but *ten* is the value of the place, and must be used consistently. Multiplication can be scalar multiples (2 km) or consists of making groups, and can be expressed by the word *times*, or find another word that expresses this better, such as *grouping*.
- (5) A key point for the standard is that it is identified where languages can make choices. Thus, a proposal for German identifies such a choice between *zig* and *ten*. It is up to German what it selects, but the standard helps German identify the choice.
- (6) If the name of 10 cannot be used as a base (e.g. German *zehn* and Dutch *tien*) then it is tried to find a close substitute already in use (e.g. *zig* in German and *tig* in Dutch), while often a clear option is to use English *ten* or scientific *deca*.
- (7) The above only gives the cardinals. There are also the ordinals (first, second, third, ...) and the fractions (that abuse the ordinals, e.g. "a fifth"). The fractions are solved

⁴ See the use of the minus-sign in the place value system (a chapter in Colignatus (2015a)): <https://boycotholland.wordpress.com/2014/08/30/taking-a-loss/>

by using $y x^H = y / x = "y \text{ per } x" (H = -1)$. The ordinals are solved by adopting a single extension, e.g. English "th" (one-th, two-th, three-th,) or Dutch "de" (een-de, twee-de, drie-de, ...). There is no linguistic morphing (Dutch *tig-de* doesn't become *tig-ste*).⁵ Colloquial words like English *first* and French *premier* will gradually adopt a meaning of "to begin with" rather than an ordinal number.

- (8) The rule is that mathematical names are used *in calculation*. The national natural language is explained as a dialect of mathematics. It is an explicit educational goal to identify the national language as such a dialect.
- (9) It will be useful to denote mathematical pronunciation with a label, say *English-M* and *Deutsch-M*. This now holds for numbers but this may apply to more phenomena later on, notably for the vocabulary. This suits translations too, e.g. Google Translate.
- (10) These principles are targeted at becoming a consensus ISO standard. Countries define their own mathematical pronunciation based upon such a standard, and include own national improvements. For example, 7 in Dutch is consistently *zeven* in 7, 27 and 70, but when Dutch changes, it might opt for a single syllable *zeef* anyway. English might prefer *thir* over *three*, with *thirteen*, *thirty* and *third* then becoming *ten & thir*, *thir-ten* and *thir-th*. (This choice though is not likely, because of potential confusion between *thir-ten* and *thirteen*.)

A suggestion is to have an expert meeting on this. In the mean time it still seems wise to provide this paper that identifies the issue. While the proposals in this paper may already be used in research to enhance comparability, ISO & national standards would be needed for further use such as in official education requirements (US Common Core) and eventually national adoption also in courts of justice.

Amendment May 14 2018

Colignatus (2018) (update today or later) provides software in *Mathematica* to show how it all would hear and look, taking advantage of the modern facilities for sounds and translation. Revisiting the issue causes the following amendments.

(1) The symbol \mathcal{D} (capital eth) can be used as symbolic 10, and be pronounced as "deka". The number 10 is universal already, but when each language pronounces it differently, then the universal pronunciation of $\mathcal{D} = 10 = \text{deka}$ may help at times. For example, \mathcal{D}^0 , \mathcal{D}^1 , \mathcal{D}^2 , \mathcal{D}^3 , ... indicates the place values and does not invite to do an actual calculation.

(2) It is better to use the (smaller) ampersand (&) to separate the place value positions. This is used above but is a major revision of the earlier text of 2015 and deserves clarification. Thus also for higher positions as e.g. 657 = six-hundred & five-ten & seven.

The connectives "&" and "." have an important role in the pronunciation and writing of the words of the numbers. They differ from the mathematical operators "plus" and "group" (multi-plus), since + and \times have commutation, association and distribution.

- The ampersand (&) is the ghost of addition, but simply "and", and not as the operator "plus" with all its properties. The ampersand should be pronounced to separate the place value positions. It is already (often) pronounced in German, Dutch and Danish, and other languages better adopt this practice too. It may take some time to get used to this but afterwards you will wonder why you never did before.
- The center dot (not pronounced) is the ghost of multiplication of the weight and the place value. It is not pure multiplication, like 5 days 2 hamburgers is not quite the same as 2 days 5 hamburgers.

⁵ See the importance of the ordinals for developing number sense (a chapter in Colignatus (2015a)): <https://boycottholland.wordpress.com/2014/08/01/is-zero-an-ordinal-or-cardinal-number-q/>

Kids in kindergarten and Grade 1 live in a world of sounds. Thus it is important to also provide them with the &-separator of the place value positions, so that they have this anchor to distinguish which from what. For adults and native speakers of English it may seem superfluous. Indeed, I myself in (2015a, footnote 10, and also the former version of this proposal for a standard) found the use of "&" "distractive", and proposed to use the center dot for "&" too: thus as $25 = \text{two}\cdot\text{ten}\cdot\text{five}$, without the distinction and merely as an unpronounced connective,. However, after much consideration, the empirical observation is that the &-separator really is there. Its existence must be acknowledged instead of hidden from sight.

Namely, in natural language, putting two terms alongside, like in 2 km, means a scalar multiplication. In multiplication as grouping, kids learn to use the times-symbol, but you do not use it for 2 km, like $2 \times 1 \text{ km}$. Later students will learn that $2 a$ is multiplication in general, also dropping the times-symbol. If they would have been trained by the pronunciation of the very numbers (and this a would be a number, in this scenario like in $a = 25 = \text{two}\cdot\text{ten}\cdot\text{five}$, thus without the "&") then we create a conundrum: (i) within " $a = 25 = \text{two}\cdot\text{ten}\cdot\text{five}$ " the lack of an interfix means addition and (ii) outside of this, in $2 a$, the lack of an interfix means multiplication ? We should not create conundrums. Thus $25 = \text{two}\cdot\text{ten} \& \text{five}$.

Indeed, in kindergarten and Grade 1 kids will tend to focus on the & as an important new symbol in their universe, but this is not "distractive" but only fortunate, because it will form a stepping stone for the later learning on addition, i.e. using plus. Eventually they would tend to focus on the figures in the numbers and not the connectives.

Implementation

The implementation of these principles of design to English, German, French, Dutch and Danish results in the proposals in the **Appendix**. They are also used in *Marcus learns counting and arithmetic with ten* in Colignatus (2015a) and its online translations.

For English, German, Dutch and Danish we skip the elaboration of the numbers 50-100 since these follow the system from 20-50.

For French, the numbers for 70-99 are fully written out however. This again shows the difficulty of international comparisons.

Conclusions

The mathematical pronunciation of numbers is straightforward. The only bottleneck is consensus, as language tends to be social phenomenon. (It remains amazing that two people who haven't met before appear able to speak the same language.)

The principles of design are based upon the place value system, full adherence, minimal distance from current natural language, and a preference for short words. The principles allow the identification of choices to be made.

A prospective implementation is useful, firstly as an example of what it all might mean, secondly to provide researchers, who cannot wait for (inter-) national consensus to continue with their research goals, with a baseline suggestion. Both aspects would support the process towards such ISO & national results.

Appendix: Proposed implementations

English

"&"= "and". The ordinals use -th, e.g. *one·th, two·th, three·th,* There is tension between current *three-ten·ths* (3 /10) and mathematical *three·ten·th* (30·th), but calculation is done with mathematical name *three·per·ten*.

zero	0
one	1
two	2
three	3
four	4
five	5
six	6
seven	7
eight	8
nine	9
ten	10

Ten to five·ten

English-M

ten	10
ten & one	11
ten & two	12
ten & three	13
ten & four	14
ten & five	15
ten & six	16
ten & seven	17
ten & eight	18
ten & nine	19
two·ten	20

Current English

ten
eleven
twelve
thirteen
fourteen
fifteen
sixteen
seventeen
eighteen
nineteen
twenty

English-M

two·ten	20
two·ten & one	21
two·ten & two	22
two·ten & three	23
two·ten & four	24
two·ten & five	25
two·ten & six	26
two·ten & seven	27
two·ten & eight	28
two·ten & nine	29
three·ten	30

Current English

twenty
twenty·one
twenty·two
twenty·three
twenty·four
twenty·five
twenty·six
twenty·seven
twenty·eight
twenty·nine
thirty

English-M

three·ten	30
three·ten & one	31
three·ten & two	32
three·ten & three	33
three·ten & four	34
three·ten & five	35
three·ten & six	36
three·ten & seven	37
three·ten & eight	38
three·ten & nine	39
four·ten	40

Current English

thirty
thirty·one
thirty·two
thirty·three
thirty·four
thirty·five
thirty·six
thirty·seven
thirty·eight
thirty·nine
forty

English-M

four·ten	40
four·ten & one	41
four·ten & two	42
four·ten & three	43
four·ten & four	44
four·ten & five	45
four·ten & six	46
four·ten & seven	47
four·ten & eight	48
four·ten & nine	49
five·ten	50

Current English

forty
forty·one
forty·two
forty·three
forty·four
forty·five
forty·six
forty·seven
forty·eight
forty·nine
fifty

Numbers of ten*English-M*

ten	10
two·ten	20
three·ten	30
four·ten	40
five·ten	50
six·ten	60
seven·ten	70
eight·ten	80
nine·ten	90
ten·ten, hundred	100

Current English

ten
twenty
thirty
forty
fifty
sixty
seventy
eighty
ninety
hundred

Ten to million: keep using the current language

10 ¹	ten
10 ²	ten·ten
10 ³	ten·ten·ten
10 ⁴	ten·ten·ten·ten
10 ⁵	ten·ten·ten·ten·ten
10 ⁶	ten·ten·ten·ten·ten·ten

Current English

10	ten
100	hundred
1,000	thousand
10,000	ten·thousand
100,000	hundred·thousand
1,000,000	million

German

The choice of *zig* instead of *zehn* cannot be avoided because of the confusion between *neunzehn* (*zig* & *neun*) and *neunzig* (*neun*·*zig*) if *zehn* were used. It remains an option to use English *ten* or scientific *deca*, but this seems unnecessary and unlikely.

"&"= "und". The choices of *ein* instead of *eins* and *sieb* instead of *sieben* are optional. Given that *ein* and *sieb* already are used, as in *ein-und-siebzig*, I have opted to use them universally.

The ordinals would use *-te*, e.g. *ein-te*, *zwei-zig* & *ein-te*.

null	0
ein, eins	1
zwei	2
drei	3
vier	4
fünf	5
sechs	6
sieb, sieben	7
acht	8
neun	9
zig, zehn	10

Zig zu fünf-zig

Deutsch-M

zig	10
zig & ein	11
zig & zwei	12
zig & drei	13
zig & vier	14
zig & fünf	15
zig & sechs	16
zig & sieb	17
zig & acht	18
zig & neun	19
zwei-zig	20

Deutsch heute (current German)

zehn
elf
zwölf
dreizehn
vierzehn
fünfzehn
sechzehn
siebzehn
achtzehn
neunzehn
zwanzig

Deutsch-M

zwei-zig	20
zwei-zig & ein	21
zwei-zig & zwei	22
zwei-zig & drei	23
zwei-zig & vier	24
zwei-zig & fünf	25
zwei-zig & sechs	26
zwei-zig & sieb	27
zwei-zig & acht	28
zwei-zig & neun	29
drei-zig	30

Deutsch heute

zwanzig
ein-und-zwanzig
zwei-und-zwanzig
drei-und-zwanzig
vier-und-zwanzig
fünf-und-zwanzig
sechs-und-zwanzig
sieben-und-zwanzig
acht-und-zwanzig
neun-und-zwanzig
dreißig

Deutsch-M

drei·zig	30
drei·zig & ein	31
drei·zig & zwei	32
drei·zig & drei	33
drei·zig & vier	34
drei·zig & fünf	35
drei·zig & sechs	36
drei·zig & sieb	37
drei·zig & acht	38
drei·zig & neun	39
vier·zig	40

Deutsch heute

dreißig	
ein·und·dreißig	
zwei·und·dreißig	
drei·und·dreißig	
vier·und·dreißig	
fünf·und·dreißig	
sechs·und·dreißig	
sieben·und·dreißig	
acht·und·dreißig	
neun·und·dreißig	
vierzig	

Deutsch-M

vier·zig	40
vier·zig & ein	41
vier·zig & zwei	42
vier·zig & drei	43
vier·zig & vier	44
vier·zig & fünf	45
vier·zig & sechs	46
vier·zig & sieb	47
vier·zig & acht	48
vier·zig & neun	49
fünf·zig	50

Deutsch heute

vierzig	
ein·und·vierzig	
zwei·und·vierzig	
drei·und·vierzig	
vier·und·vierzig	
fünf·und·vierzig	
sechs·und·vierzig	
sieben·und·vierzig	
acht·und·vierzig	
neun·und·vierzig	
fünfzig	

The numbers of zig*Deutsch-M*

zig	10
zwei·zig	20
drei·zig	30
vier·zig	40
fünf·zig	50
sechs·zig	60
sieb·zig	70
acht·zig	80
neun·zig	90
zig·zig, hundert	100

Deutsch heute

zig	
zwanzig	
dreißig	
vierzig	
fünfzig	
sechzig	
siebzig	
achtzig	
neunzig	
hundert	

Ten to million: keep using the current language above zig

10 ¹	zig
10 ²	zig·zig
10 ³	zig·zig·zig
10 ⁴	zig·zig·zig·zig
10 ⁵	zig·zig·zig·zig·zig
10 ⁶	zig·zig·zig·zig·zig·zig

	<i>Deutsch heute</i>
10	zehn
100	hundert
1,000	tausend
10,000	zig·tausend
100,000	hundert·tausend
1,000,000	Million

French

In French there is no problem in taking *dix* as the base for the numbers of ten.

The numbers of 70-100 are fully written out because of the complex French originals.

"&"= "et". The ordinals would be *-ième*: *un·ième, deux·ième, ...*

zéro	0
un	1
deux	2
trois	3
quatre	4
cinq	5
six	6
sept	7
huit	8
neuf	9
dix	10

Dix to cinq-dix

Français-M

dix	10
dix & un	11
dix & deux	12
dix & trois	13
dix & quatre	14
dix & cinq	15
dix & six	16
dix & sept	17
dix & huit	18
dix & neuf	19
deux·dix	20

Français aujourd'hui

dix
onze
douze
treize
quatorze
quinze
seize
dix·sept
dix·huit
dix·neuf
vingt

Français-M

deux·dix	20
deux·dix & un	21
deux·dix & deux	22
deux·dix & trois	23
deux·dix & quatre	24
deux·dix & cinq	25
deux·dix & six	26
deux·dix & sept	27
deux·dix & huit	28
deux·dix & neuf	29
trois·dix	30

Français aujourd'hui

vingt
vingt et un
vingt·deux
vingt·trois
vingt·quatre
vingt·cinq
vingt·six
vingt·sept
vingt·huit
vingt·neuf
trente

Français-M

trois·dix	30
trois·dix & un	31
trois·dix & deux	32
trois·dix & trois	33
trois·dix & quatre	34
trois·dix & cinq	35
trois·dix & six	36
trois·dix & sept	37
trois·dix & huit	38
trois·dix & neuf	39
quatre·dix	40

Français-M

quatre·dix	40
quatre·dix & un	41
quatre·dix & deux	42
quatre·dix & trois	43
quatre·dix & quatre	44
quatre·dix & cinq	45
quatre·dix & six	46
quatre·dix & sept	47
quatre·dix & huit	48
quatre·dix & neuf	49
cinq·dix	50

Français-M

sept·dix	70
sept·dix & un	71
sept·dix & deux	72
sept·dix & trois	73
sept·dix & quatre	74
sept·dix & cinq	75
sept·dix & six	76
sept·dix & sept	77
sept·dix & huit	78
sept·dix & neuf	79
huit·dix	80

huit·dix	80
huit·dix & un	81
huit·dix & deux	82
huit·dix & trois	83
huit·dix & quatre	84
huit·dix & cinq	85
huit·dix & six	86
huit·dix & sept	87
huit·dix & huit	88
huit·dix & neuf	89
neuf·dix	90

Français aujourd'hui

trente
trente et un
trente·deux
trente·trois
trente·quatre
trente·cinq
trente·six
trente·sept
trente·huit
trente·neuf
quarante

Français aujourd'hui

quarante
quarante et un
quarante·deux
quarante·trois
quarante·quatre
quarante·cinq
quarante·six
quarante·sept
quarante·huit
quarante·neuf
cinquante

Français aujourd'hui

soixante·dix
soixante et onze
soixante·douze
soixante·treize
soixante·quatorze
soixante·quinze
soixante·seize
soixante·dix·sept
soixante·dix·huit
soixante·dix·neuf
quatre·vingts

quatre·vingts
quatre·vingt·un
quatre·vingt·deux
quatre·vingt·trois
quatre·vingt·quatre
quatre·vingt·cinq
quatre·vingt·six
quatre·vingt·sept
quatre·vingt·huit
quatre·vingt·neuf
quatre·vingt·dix

neuf·dix	90
neuf·dix & un	91
neuf·dix & deux	92
neuf·dix & trois	93
neuf·dix & quatre	94
neuf·dix & cinq	95
neuf·dix & six	96
neuf·dix & sept	97
neuf·dix & huit	98
neuf·dix & neuf	99
dix·dix, cent	100

quatre·vingt·dix
quatre·vingt et onze
quatre·vingt·douze
quatre·vingt·treize
quatre·vingt·quatorze
quatre·vingt·quize
quatre·vingt·seize
quatre·vingt·dix·sept
quatre·vingt·dix·huit
quatre·vingt·dix·neuf
cent

The numbers of dix

Français-M

dix	10
deux·dix	20
trois·dix	30
quatre·dix	40
cinq·dix	50
six·dix	60
sept·dix	70
huit·dix	80
neuf·dix	90
dix·dix	100

Français aujourd'hui

dix
vingt
trente
quarante
cinquante
soixante
soixante·dix
quatre·vingts
quatre·vingt·dix
cent

Ten to million: keep using the current language

			<i>Français aujourd'hui</i>
10 ¹	dix	10	dix
10 ²	dix·dix	100	cent
10 ³	dix·dix·dix	1,000	mille
10 ⁴	dix·dix·dix·dix	10,000	dix·mille
10 ⁵	dix·dix·dix·dix·dix	100,000	cent·mille
10 ⁶	dix·dix·dix·dix·dix·dix	1,000,000	million

Dutch

The choice of *tig* instead of *tien* cannot be avoided because of the confusion between *negentien* (tig & negen) and *negentig* (negen·tig) if *tien* were used. It remains an option to use English *ten*, but this seems unnecessary and unlikely. “&”= “en”.

Ordinals use -de: *een·de, twee·de, drie·de, ..., tig·de,*

nul	0
een	1
twee	2
drie	3
vier	4
vijf	5
zes	6
zeven	7
acht	8
negen	9
tig, tien	10

From ten to fifty

Nederlands-M

tig	10
tig & een	11
tig & twee	12
tig & drie	13
tig & vier	14
tig & vijf	15
tig & zes	16
tig & zeven	17
tig & acht	18
tig & negen	19
twee·tig	20

Huidig Nederlands

tien
elf
twaalf
dertien
veertien
vijftien
zestien
zeventien
achttien
negentien
twintig

Nederlands-M

twee·tig	20
twee·tig & een	21
twee·tig & twee	22
twee·tig & drie	23
twee·tig & vier	24
twee·tig & vijf	25
twee·tig & zes	26
twee·tig & zeven	27
twee·tig & acht	28
twee·tig & negen	29
drie·tig	30

Huidig Nederlands

twintig
een·en·twintig
twee·en·twintig
drie·en·twintig
vier·en·twintig
vijf·en·twintig
zes·en·twintig
zeven·en·twintig
acht·en·twintig
negen·en·twintig
dertig

Nederlands-M

drie·tig	30
drie·tig & een	31
drie·tig & twee	32
drie·tig & drie	33
drie·tig & vier	34
drie·tig & vijf	35
drie·tig & zes	36
drie·tig & zeven	37
drie·tig & acht	38
drie·tig & negen	39
vier·tig	40

Huidig Nederlands

dertig
een·en·dertig
twee·en·dertig
drie·en·dertig
vier·en·dertig
vijf·en·dertig
zes·en·dertig
zeven·en·dertig
acht·en·dertig
negen·en·dertig
veertig

Nederlands-M

vier·tig	40
vier·tig & een	41
vier·tig & twee	42
vier·tig & drie	43
vier·tig & vier	44
vier·tig & vijf	45
vier·tig & zes	46
vier·tig & zeven	47
vier·tig & acht	48
vier·tig & negen	49
vijf·tig	50

Huidig Nederlands

veertig
een·en·veertig
twee·en·veertig
drie·en·veertig
vier·en·veertig
vijf·en·veertig
zes·en·veertig
zeven·en·veertig
acht·en·veertig
negen·en·veertig
vijftig

The numbers of tig*Nederlands-M*

tig	10
twee·tig	20
drie·tig	30
vier·tig	40
vijf·tig	50
zes·tig	60
zeven·tig	70
acht·tig	80
negen·tig	90
tig·tig, honderd	100

Huidig Nederlands

tien
twintig
dertig
veertig
vijftig
zestig
zeventig
tachtig
negentig
honderd

Ten to million: keep using the current language above tig*Huidig Nederlands*

10 ¹	tig	10	tien
10 ²	tig·tig	100	honderd
10 ³	tig·tig·tig	1,000	duizend
10 ⁴	tig·tig·tig·tig	10,000	tig·duizend
10 ⁵	tig·tig·tig·tig·tig	100,000	honderd·duizend
10 ⁶	tig·tig·tig·tig·tig·tig	1,000,000	miljoen

Danish

Danish can use current *ti* as below, but also has the option to use English *ten*.

"&"= "og". For the ordinals a suggestion would be to use *-de* like English *-th*.

nul	0
en	1
to	2
tre	3
fire	4
fem	5
seks	6
syv	7
otte	8
ni	9
ti	10

From ten to fifty

Dansk-M

ti	10
ti & en	11
ti & to	12
ti & tre	13
ti & fire	14
ti & fem	15
ti & seks	16
ti & syv	17
ti & otte	18
ti & ni	19
to-ti	20

Dansk i dag

ti
elleve
tolv
tretten
fjorten
femten
seksten
sytten
atten
nitten
tyve

Dansk-M

to-ti	20
to-ti & en	21
to-ti & to	22
to-ti & tre	23
to-ti & fire	24
to-ti & fem	25
to-ti & seks	26
to-ti & syv	27
to-ti & otte	28
to-ti & ni	29
tre-ti	30

Dansk i dag

tyve
en-og-tyve
to-og-tyve
tre-og-tyve
fire-og-tyve
fem-og-tyve
seks-og-tyve
syv-og-tyve
otte-og-tyve
ni-og-tyve
tredive

Dansk-M

tre·ti	30
tre·ti & en	31
tre·ti & to	32
tre·ti & tre	33
tre·ti & fire	34
tre·ti & fem	35
tre·ti & seks	36
tre·ti & syv	37
tre·ti & otte	38
tre·ti & ni	39
fire·ti	40

Dansk i dag

tredive
en·og·tredive
to·og·tredive
tre·og·tredive
fire·og·tredive
fem·og·tredive
seks·og·tredive
syv·og·tredive
otte·og·tredive
ni·og·tredive
fyrre

Dansk-M

fire·ti	40
fire·ti & en	41
fire·ti & to	42
fire·ti & tre	43
fire·ti & fire	44
fire·ti & fem	45
fire·ti & seks	46
fire·ti & syv	47
fire·ti & otte	48
fire·ti & ni	49
fem·ti	50

Dansk i dag

fyrre
en·og·fyrre
to·og·fyrre
tre·og·fyrre
fire·og·fyrre
fem·og·fyrre
seks·og·fyrre
syv·og·fyrre
otte·og·fyrre
ni·og·fyrre
halvtreds

The numbers of ti*Dansk-M*

ti	10
to·ti	20
tre·ti	30
fire·ti	40
fem·ti	50
seks·ti	60
syv·ti	70
otte·ti	80
ni·ti	90
ti·ti, hundrede	100

Dansk i dag

ti
tyve
tredive
fyrre
halvtreds
tres
halvfjerds
firs
halvfems
hundrede

Ten to million: keep using the current language*Dansk i dag*

10 ¹	ti	10	ti
10 ²	ti·ti	100	hundrede
10 ³	ti·ti·ti	1,000	tusind
10 ⁴	ti·ti·ti·ti	10,000	ti·tusind
10 ⁵	ti·ti·ti·ti·ti	100,000	hundrede·tusind
10 ⁶	ti·ti·ti·ti·ti·ti	1,000,000	million

References

PM 1. Colignatus is the name of Thomas Cool in science.

PM 2. References in footnotes need not be repeated here.

- Colignatus, Th. (2015a), "A child wants nice and no mean numbers", ISBN 978-946318970-5, <http://thomascool.eu/Papers/NiceNumbers/Index.html>, or <https://zenodo.org/record/291979>
- Colignatus, Th. (2015b), "Elegance with Substance", <http://thomascool.eu/Papers/Math/Index.html> or <https://zenodo.org/record/291974>
- Colignatus, Th. (2018), "Pronunciation of the integers with full use of the place value system", <https://zenodo.org/record/1244063> and software <https://doi.org/10.5281/zenodo.1244008>
- Dowker, A., M. Roberts (2015), "Does the transparency of the counting system affect children's numerical abilities?", *Front. Psychol.*, 6:945, <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4493320/>
- Ejersbo, L. R., M. Misfeldt (2015), "The relationship between number names and number concepts", Paper presented at ICMI Sudy-23, Macau SAR, China. In press
- Friso - Van den Bos, I. (2014), "Making sense of numbers : early mathematics achievement and working memory in primary school children", Thesis University of Utrecht, <http://dspace.library.uu.nl/handle/1874/297856>
- Klein, E., J. Bahnmüller, A. Mann, S. Pixner, L. Kaufmann, H.-C. Nuerk, and K. Moeller (2013), "Language influences on numerical development—Inversion effects on multi-digit number processing", *Front. Psychol* 4:480, <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3733006/>
- Mark, W., A. Dowker (2015), "Linguistic influence on mathematical development is specific rather than pervasive: revisiting the Chinese Number Advantage in Chinese and English children", *Front Psychol.*, 6:203, <http://www.ncbi.nlm.nih.gov/pubmed/25767456>
- Moeller, K., S. Pixner, J. Zuber, L. Kaufmann, H.-C. Nuerk (2011), "Early place-value understanding as a precursor for later arithmetic performance--a longitudinal study on numerical development", *Res Dev Disabil.* 2011 Sep-Oct;32(5):1837-51, <http://www.ncbi.nlm.nih.gov/pubmed/21498043>
- Pixner, S., J. Zuber, V. Heřmanová, L. Kaufmann, H.-C. Nuerk, K. Moeller (2011), "One language, two number-word systems and many problems: numerical cognition in the Czech language", *Res Dev Disabil.* 2011 Nov-Dec;32(6):2683-9, <http://www.ncbi.nlm.nih.gov/pubmed/21763104>
- Schuh, F. (1949), "De macht van het Getal", Segboer uitgevers-maatschappij, The Hague
- Shellenbarger, S. (2014), "The Best Language for Math. Confusing English Number Words Are Linked to Weaker Skills", *Wall St. Journal*, September 15, <http://www.wsj.com/articles/the-best-language-for-math-1410304008>
- Stoffels, E.J. (1952), "Spreek getallen uit zoals we ze schrijven!", *De Telegraaf* (newspaper), March 29, page 3
- Zuber, J., S. Pixner, K. Moeller, H.-C. Nuerk (2009), "On the language specificity of basic number processing: transcoding in a language with inversion and its relation to working memory capacity", *J Exp Child Psychol.* 2009 Jan;102(1):60-77, <http://www.ncbi.nlm.nih.gov/pubmed/18499120>
- Xenidou-Dervou, I. (2015), "Setting the Foundations for Match Achievement:: Working Memory, Nonsymbolic and Symbolic Numerosity Processing", Thesis University of Amsterdam, <http://dare.uvu.vu.nl/handle/1871/52176>
- Xenidou-Dervou, I., C. Gilmore, M. van der Schoot, E.C. van Lieshout (2015), "The developmental onset of symbolic approximation: beyond nonsymbolic representations, the language of numbers matters", *Front Psychol.* 2015 Apr 29;6:487, <http://www.ncbi.nlm.nih.gov/pubmed/25972822>