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

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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

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Introduction

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 influential authors and often even committees. 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.matematikksenteret.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.

Recent 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* × hundred + *b* × ten + *a* = …*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 × 10 + 4 = 24).

(2) In writing out the pronunciation, also in educational texts, the connectives middle-dot (unpronounced) and ampersand (pronounced) are used. We thus say *five·ten* & *nine* for 59, where the dot is not pronounced and the order helps to decode the position. The middle dot is preferred over the hyphen since the latter may be confused with the minus-sign. [4]

(3) **Insert August 20 2018:** (3a) For everyday use (in school) there is simplification in the pronunciation of 1 and 0. The proposed standard has simplified 11 = "ten & one" and not the nonsimplified "one·ten & one·one". (3b) On occasion the nonsimplified form can be used. A teaching objective is that pupils should understand the positional system, and the nonsimplified pronunciation indeed is more informative on this than the simplified pronunciation. However, while the nonsimplified form must be shown for such purpose, the everyday use is served by the simplified form. See Colignatus (2018) for software that can show both forms, with default simplification. See below for more discussion of this aspect in education.

(4) 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 it 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*).

(5) 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

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

consists of making groups, and can be expressed by the word *times,* or find another word that expresses this better, such as *grouping.*

(6) 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.

(7) 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.*

(8) 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 by using $y\ x^H = y / x =$ "*y* 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.

(9) 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.

(10) 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.

(11) 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 *Ð* (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 $Ð = 10 =$ deka may help at times. For example, $Ð^0$, $Ð^1$, $Ð^2$, $Ð^3$, ... 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.

[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/

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 × 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.

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 proporal for a standard) found the use of “&” "distractive", and proposed to use the center dot for “&” too: thus as 25 = two·ten·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 × 1 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 = two·ten·five, thus without the “&”) then we create a conundrum: (1) within "*a* = 25 = two·ten·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 = two·ten & 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.

Addendum June 28 2018. (i) New findings Van der Ven et al. (2017) and Bussi et al. (eds) (2018) have not been included here but may be mentioned. (ii) I discovered that there is the use of “tigus” (proto-Germanic) and “tigjus” (Gothic) for 10s (more sources). (iii) This suggestion to achieve a standard finds support at https://zwanzigeins.jetzt

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 though with the need of updating to the May 14 2018 amendment.)

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.

Addendum August 20 2018. The pronunciation in the natural language is called “partial” with respect to the place value system. Education and research are better served with the full pronunciation. Colignatus (2018) shows (also with software) how the full pronunciation has a basic nonsimplified form while everyday use is better served with simplification.

See above point (3) on teaching of the place value system and simplification. There are (3a) the standard for everyday use (in school) with simplification, and (3b) the question how to teach the positional system and the proposed standard with simplification. This teaching might need its own standard too. However, didactics would require more research. Thus the following considerations are preliminary:

(1) The proposed standard for everyday use has simplification. It is more natural to pronounce 9 as “nine” instead of “nine·one”.
(2) It is most sensible to start from day 1 in kindergarten with using the proposed standard with the simplified pronunciation. This is what the pupils must learn. It would be problematic to first learn the nonsimplified form and later unlearn it again.
(3) The nonsimplified pronunciation must occur at least sometimes during education, to clarify to pupils how the positional system works, and to clarify the role of zero.
(4) Researchers who have wondered about the basic or the simplified form as a standard, better see this as an issue in didactics. There is no need for uncertainty about what the standard for everyday use should be. There is only the empirical question about the didactics of (4a) the place value system and (4b) its simplification in pronunciation. (I thank Peter Morfeld of Zwanzigeins for a discussion on this.)

A suggestion for the didactics is as follows. Suppose that a bike has an odometer (distance meter) and that the display changes as in below table (imagine the digit-wheels turning). The pure pronunciation clearly shows the positional values and their weights. This allows pupils to get to understand how this system works and why zero is so important. A principle is that leading zero’s are not pronounced, so that 9 is nine·one without simplification but 109 would give one.hundred & zero·ten & nine·one.

Last two digits in an odometer	*Nonsimplified pronunciation*	*Simplified*
...09	(zero·ten &) nine·one	nine
...10	one·ten & zero·one	ten
...11	one·ten & one·one	ten & one

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		*Current English*
ten	10	ten
ten & one	11	eleven
ten & two	12	twelve
ten & three	13	thirteen
ten & four	14	fourteen
ten & five	15	fifteen
ten & six	16	sixteen
ten & seven	17	seventeen
ten & eight	18	eighteen
ten & nine	19	nineteen
two·ten	20	twenty

English-M		*Current English*
two·ten	20	twenty
two·ten & one	21	twenty·one
two·ten & two	22	twenty·two
two·ten & three	23	twenty·three
two·ten & four	24	twenty·four
two·ten & five	25	twenty·five
two·ten & six	26	twenty·six
two·ten & seven	27	twenty·seven
two·ten & eight	28	twenty·eight
two·ten & nine	29	twenty·nine
three·ten	30	thirty

English-M		*Current English*
three·ten	30	thirty
three·ten & one	31	thirty·one
three·ten & two	32	thirty·two
three·ten & three	33	thirty·three
three·ten & four	34	thirty·four
three·ten & five	35	thirty·five
three·ten & six	36	thirty·six
three·ten & seven	37	thirty·seven
three·ten & eight	38	thirty·eight
three·ten & nine	39	thirty·nine
four·ten	40	forty

English-M		*Current English*
four·ten	40	forty
four·ten & one	41	forty·one
four·ten & two	42	forty·two
four·ten & three	43	forty·three
four·ten & four	44	forty·four
four·ten & five	45	forty·five
four·ten & six	46	forty·six
four·ten & seven	47	forty·seven
four·ten & eight	48	forty·eight
four·ten & nine	49	forty·nine
five·ten	50	fifty

Numbers of ten

English-M		*Current English*
ten	10	ten
two·ten	20	twenty
three·ten	30	thirty
four·ten	40	forty
five·ten	50	fifty
six·ten	60	sixty
seven·ten	70	seventy
eight·ten	80	eighty
nine·ten	90	ninety
ten·ten, hundred	100	hundred

Ten to million: keep using the current language

			Current English
10^1	ten	10	ten
10^2	ten·ten	100	hundred
10^3	ten·ten·ten	1,000	thousand
10^4	ten·ten·ten·ten	10,000	ten·thousand
10^5	ten·ten·ten·ten·ten	100,000	hundred·thousand
10^6	ten·ten·ten·ten·ten·ten	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		*Deutsch heute* (current German)
zig	10	zehn
zig & ein	11	elf
zig & zwei	12	zwölf
zig & drei	13	dreizehn
zig & vier	14	vierzehn
zig & fünf	15	fünfzehn
zig & sechs	16	sechzehn
zig & sieb	17	siebzehn
zig & acht	18	achtzehn
zig & neun	19	neunzehn
zwei·zig	20	zwanzig

Deutsch-M		*Deutsch heute*
zwei·zig	20	zwanzig
zwei·zig & ein	21	ein·und·zwanzig
zwei·zig & zwei	22	zwei·und·zwanzig
zwei·zig & drei	23	drei·und·zwanzig
zwei·zig & vier	24	vier·und·zwanzig
zwei·zig & fünf	25	fünf·und·zwanzig
zwei·zig & sechs	26	sechs·und·zwanzig
zwei·zig & sieb	27	sieben·und·zwanzig
zwei·zig & acht	28	acht·und·zwanzig
zwei·zig & neun	29	neun·und·zwanzig
drei·zig	30	dreißig

Deutsch-M		*Deutsch heute*
drei·zig	30	dreißig
drei·zig & ein	31	ein·und·dreißig
drei·zig & zwei	32	zwei·und·dreißig
drei·zig & drei	33	drei·und·dreißig
drei·zig & vier	34	vier·und·dreißig
drei·zig & fünf	35	fünf·und·dreißig
drei·zig & sechs	36	sechs·und·dreißig
drei·zig & sieb	37	sieben·und·dreißig
drei·zig & acht	38	acht·und·dreißig
drei·zig & neun	39	neun·und·dreißig
vier·zig	40	vierzig

Deutsch-M		*Deutsch heute*
vier·zig	40	vierzig
vier·zig & ein	41	ein·und·vierzig
vier·zig & zwei	42	zwei·und·vierzig
vier·zig & drei	43	drei·und·vierzig
vier·zig & vier	44	vier·und·vierzig
vier·zig & fünf	45	fünf·und·vierzig
vier·zig & sechs	46	sechs·und·vierzig
vier·zig & sieb	47	sieben·und·vierzig
vier·zig & acht	48	acht·und·vierzig
vier·zig & neun	49	neun·und·vierzig
fünf·zig	50	fünfzig

The numbers of zig

Deutsch-M		*Deutsch heute*
zig	10	zig
zwei·zig	20	zwanzig
drei·zig	30	dreißig
vier·zig	40	vierzig
fünf·zig	50	fünfzig
sechs·zig	60	sechzig
sieb·zig	70	siebzig
acht·zig	80	achtzig
neun·zig	90	neunzig
zig·zig, hundert	100	hundert

Ten to million: keep using the current language above zig

			Deutsch heute
10^1	zig	10	zehn
10^2	zig·zig	100	hundert
10^3	zig·zig·zig	1,000	tausend
10^4	zig·zig·zig·zig	10,000	zig·tausend
10^5	zig·zig·zig·zig·zig	100,000	hundert·tausend
10^6	zig·zig·zig·zig·zig·zig	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		*Français aujourd'hui*
dix	10	dix
dix & un	11	onze
dix & deux	12	douze
dix & trois	13	treize
dix & quatre	14	quatorze
dix & cinq	15	quinze
dix & six	16	seize
dix & sept	17	dix·sept
dix & huit	18	dix·huit
dix & neuf	19	dix·neuf
deux·dix	20	vingt

Français-M		*Français aujourd'hui*
deux·dix	20	vingt
deux·dix & un	21	vingt et un
deux·dix & deux	22	vingt·deux
deux·dix & trois	23	vingt·trois
deux·dix & quatre	24	vingt·quatre
deux·dix & cinq	25	vingt·cinq
deux·dix & six	26	vingt·six
deux·dix & sept	27	vingt·sept
deux·dix & huit	28	vingt·huit
deux·dix & neuf	29	vingt·neuf
trois·dix	30	trente

Français-M		*Français aujourd'hui*
trois·dix	30	trente
trois·dix & un	31	trente et un
trois·dix & deux	32	trente·deux
trois·dix & trois	33	trente·trois
trois·dix & quatre	34	trente·quatre
trois·dix & cinq	35	trente·cinq
trois·dix & six	36	trente·six
trois·dix & sept	37	trente·sept
trois·dix & huit	38	trente·huit
trois·dix & neuf	39	trente·neuf
quatre·dix	40	quarante

Français-M		*Français aujourd'hui*
quatre·dix	40	quarante
quatre·dix & un	41	quarante et un
quatre·dix & deux	42	quarante·deux
quatre·dix & trois	43	quarante·trois
quatre·dix & quatre	44	quarante·quatre
quatre·dix & cinq	45	quarante·cinq
quatre·dix & six	46	quarante·six
quatre·dix & sept	47	quarante·sept
quatre·dix & huit	48	quarante·huit
quatre·dix & neuf	49	quarante·neuf
cinq·dix	50	cinquante

Français-M		*Français aujourd'hui*
sept·dix	70	soixante·dix
sept·dix & un	71	soixante et onze
sept·dix & deux	72	soixante·douze
sept·dix & trois	73	soixante·treize
sept·dix & quatre	74	soixante·quatorze
sept·dix & cinq	75	soixante·quinze
sept·dix & six	76	soixante·seize
sept·dix & sept	77	soixante·dix·sept
sept·dix & huit	78	soixante·dix·huit
sept·dix & neuf	79	soixante·dix·neuf
huit·dix	80	quatre·vingts

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

neuf·dix	90	quatre·vingt·dix
neuf·dix & un	91	quatre·vingt et onze
neuf·dix & deux	92	quatre·vingt·douze
neuf·dix & trois	93	quatre·vingt·treize
neuf·dix & quatre	94	quatre·vingt·quatorze
neuf·dix & cinq	95	quatre·vingt·quize
neuf·dix & six	96	quatre·vingt·seize
neuf·dix & sept	97	quatre·vingt·dix·sept
neuf·dix & huit	98	quatre·vingt·dix·huit
neuf·dix & neuf	99	quatre·vingt·dix·neuf
dix·dix, cent	100	cent

The numbers of dix

Français-M		*Français aujourd'hui*
dix	10	dix
deux·dix	20	vingt
trois·dix	30	trente
quatre·dix	40	quarante
cinq·dix	50	cinquante
six·dix	60	soixante
sept·dix	70	soixante·dix
huit·dix	80	quatre·vingts
neuf·dix	90	quatre·vingt·dix
dix·dix	100	cent

Ten to million: keep using the current language

			Français aujourd'hui
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		*Huidig Nederlands*
tig	10	tien
tig & een	11	elf
tig & twee	12	twaalf
tig & drie	13	dertien
tig & vier	14	veertien
tig & vijf	15	vijftien
tig & zes	16	zestien
tig & zeven	17	zeventien
tig & acht	18	achttien
tig & negen	19	negentien
twee·tig	20	twintig

Nederlands-M		*Huidig Nederlands*
twee·tig	20	twintig
twee·tig & een	21	een·en·twintig
twee·tig & twee	22	twee·en·twintig
twee·tig & drie	23	drie·en·twintig
twee·tig & vier	24	vier·en·twintig
twee·tig & vijf	25	vijf·en·twintig
twee·tig & zes	26	zes·en·twintig
twee·tig & zeven	27	zeven·en·twintig
twee·tig & acht	28	acht·en·twintig
twee·tig & negen	29	negen·en·twintig
drie·tig	30	dertig

Nederlands-M		*Huidig Nederlands*
drie·tig	30	dertig
drie·tig & een	31	een·en·dertig
drie·tig & twee	32	twee·en·dertig
drie·tig & drie	33	drie·en·dertig
drie·tig & vier	34	vier·en·dertig
drie·tig & vijf	35	vijf·en·dertig
drie·tig & zes	36	zes·en·dertig
drie·tig & zeven	37	zeven·en·dertig
drie·tig & acht	38	acht·en·dertig
drie·tig & negen	39	negen·en·dertig
vier·tig	40	veertig

Nederlands-M		*Huidig Nederlands*
vier·tig	40	veertig
vier·tig & een	41	een·en·veertig
vier·tig & twee	42	twee·en·veertig
vier·tig & drie	43	drie·en·veertig
vier·tig & vier	44	vier·en·veertig
vier·tig & vijf	45	vijf·en·veertig
vier·tig & zes	46	zes·en·veertig
vier·tig & zeven	47	zeven·en·veertig
vier·tig & acht	48	acht·en·veertig
vier·tig & negen	49	negen·en·veertig
vijf·tig	50	vijftig

The numbers of tig

Nederlands-M		*Huidig Nederlands*
tig	10	tien
twee·tig	20	twintig
drie·tig	30	dertig
vier·tig	40	veertig
vijf·tig	50	vijftig
zes·tig	60	zestig
zeven·tig	70	zeventig
acht·tig	80	tachtig
negen·tig	90	negentig
tig·tig, honderd	100	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		*Dansk i dag*
ti	10	ti
ti & en	11	elleve
ti & to	12	tolv
ti & tre	13	tretten
ti & fire	14	fjorten
ti & fem	15	femten
ti & seks	16	seksten
ti & syv	17	sytten
ti & otte	18	atten
ti & ni	19	nitten
to·ti	20	tyve

Dansk-M		*Dansk i dag*
to·ti	20	tyve
to·ti & en	21	en·og·tyve
to·ti & to	22	to·og·tyve
to·ti & tre	23	tre·og·tyve
to·ti & fire	24	fire·og·tyve
to·ti & fem	25	fem·og·tyve
to·ti & seks	26	seks·og·tyve
to·ti & syv	27	syv·og·tyve
to·ti & otte	28	otte·og·tyve
to·ti & ni	29	ni·og·tyve
tre·ti	30	tredive

Dansk-M		*Dansk i dag*
tre·ti	30	tredive
tre·ti & en	31	en·og·tredive
tre·ti & to	32	to·og·tredive
tre·ti & tre	33	tre·og·tredive
tre·ti & fire	34	fire·og·tredive
tre·ti & fem	35	fem·og·tredive
tre·ti & seks	36	seks·og·tredive
tre·ti & syv	37	syv·og·tredive
tre·ti & otte	38	otte·og·tredive
tre·ti & ni	39	ni·og·tredive
fire·ti	40	fyrre

Dansk-M		*Dansk i dag*
fire·ti	40	fyrre
fire·ti & en	41	en·og·fyrre
fire·ti & to	42	to·og·fyrre
fire·ti & tre	43	tre·og·fyrre
fire·ti & fire	44	fire·og·fyrre
fire·ti & fem	45	fem·og·fyrre
fire·ti & seks	46	seks·og·fyrre
fire·ti & syv	47	syv·og·fyrre
fire·ti & otte	48	otte·og·fyrre
fire·ti & ni	49	ni·og·fyrre
fem·ti	50	halvtreds

The numbers of ti

Dansk-M		*Dansk i dag*
ti	10	ti
to·ti	20	tyve
tre·ti	30	tredive
fire·ti	40	fyrre
fem·ti	50	halvtreds
seks·ti	60	tres
syv·ti	70	halvfjerds
otte·ti	80	firs
ni·ti	90	halvfems
ti·ti, hundrede	100	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.

Bussi, M. G. B. & Sun X. H. (eds) (2018), “Building the Foundation: Whole Numbers in the Primary Grades”, The 23rd ICMI Study. Springer

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 (NB. This contains the pronunciation from before the amendment of May 2018.)

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://doi.org/10.5281/zenodo.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. Pschol., 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. Included in Sun et al. (eds) (2015)

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. Bahnmueller, 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

Sun, X., Kaur, B., & Novotna, J. (eds) (2015). “Conference proceedings of the ICMI study 23: Primary mathematics study on whole numbers”, www.umac.mo/fed/ICMI23/doc/Proceedings_ICMI_STUDY_23_final.pdf

Ven, S.H.G. van der, J.D. Klaiber & H.J.L. van der Maas (2017), “Four and twenty blackbirds: how transcoding ability mediates the relationship between visuospatial working memory and math in a language with inversion”, Educational Psychology, 37:4, 487-505

Xenidou-Dervou, I. (2015), "Setting the Foundations for Match Achievement:: Working Memory, Nonsymbolic and Symbolic Numerosity Processing", Thesis University of Amsterdam, http://dare.ubvu.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

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