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Non Verbals in English and French at Baccalaureate level: documentation of some differences

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Note. An earlier shorter version of this article was published as Lowe I 1996. Non-verbal devices in pre-university science: the extent of correspondence between English and French. *English for Specific Purposes* 15(3):217-232

The theoretical basis for this article I deal with elsewhere. This article concentrates on documenting some of the differences, and exploring some of the implications. It is based upon field work done in 1987-89, in Tunisia. This means that some of the material could well be outdated by now. Therefore readers are advised to check before regarding these differences as definitive. Also, the work was done in Tunisia, which teaches science in French. It is possible that a difference could have been due to lack of sufficient editorial checking of the locally produced textbooks. I was aware of this at the time, and would try to check with subject specialists from France and with teaching material from France. When the data was being written up for the thesis I also consulted other authorities, especially those writing for school level such as the Association for Science Education (ASE) and the Institute Of Biology (IOB).

A. SYMBOLS

1. Background to the SI system

A major argument of those in favour of the constancy of the language of science (CLS) is that the symbols used in science are assumed to be international, particularly because there exists the international system (SI) of units, supposedly one of the most fully international systems in use in the modern world. If there are major differences between English and French in this important area of symbols, it follows that CLS is not valid in one of the more important areas.

"La conférence Générale et du Comité International des Poids et Mesures" (CGPM) has been in existence since 1889. (Maillot 1981 p221). It is this body which adopted the SI, the International System of units, based upon seven base units, the metre, kilogram, second, ampere, kelvin, candela and mole. (ASE 1981 p1). Because the UK has adopted the metric system (based upon the metre, litre [1] and kilogram) one would expect few problems now between French and English, especially when units are used by scientists. The definitive guide to the SI system is *Le Système International d'Unites (SI)*. The 7th edition of the brochure, which is the current definitive reference on the SI, was published in the French language in 1998 by the International Bureau of Weights and Measures (BIPM, Bureau International des Poids et Mesures), and a supplement to it was published in June 2000. (http://physics.nist.gov/cuu/Units/bibliography.html).

2. Basic explanation of the seven base units

What I am going to write now will seem ridiculously obvious to scientists, since these seven units are foundational and are taught systematically. But this website is designed so that non-scientists should be able to follow, therefore some brief explanation is in order.

I presume we all know the units of metre, kilogram, and second. The kelvin is the unit of temperature with zero starting at absolute zero, which is -273.15 ^{0}C. Similarly, the freezing point of water, in absolute terms, is 273.15 K (read as 'kelvins', not 'degrees kelvin'). The candela is a measure of the intensity of light. The mole is a measure used frequently in chemistry to denote the amount of a substance. This amount is related to the number of atoms or molecules present rather than the weight of the substance, since this is more interesting and fundamental when chemical reactions are considered.

As I was writing this essay, largely based upon my thesis as it is, I questioned the unit of ampere as being considered basic. I had learned years ago that an ampere was a joule per coulomb, therefore surely joules and coulombs were basic, and ampere was derived? A look at http://physics.nist.gov/cuu/Units/units.html convinced me of how wrong I was.

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1. Technically the litre is a 'tolerated' unit for the sake of convenience. The official unit is something related to cubic metres. One litre equals one decimetre cubed. $1l=1dm^3$. In addition, because the symbol /l/ is difficult to read, the capital letter /L/ is also tolerated.

Of particular interest to English teachers are the rules and style conventions for SI units. Interesting partly because local usage may well be careless, and because part of English teaching is helping our students to publish in English. The following page leads to a printable pdf file for authors.. http://physics.nist.gov/cuu/Units/rules.html

After the seven basic units there are 22 derived units with special names and symbols, and these are in common use in science, and may even be confused as basic units as I did.

3. The distinction between quantity and unit

In the SI system, a distinction is made between 'quantity' (grandeur) and 'unit' (unités). Quantity, is a dimension, or a measure, such as the length, breadth or height of an object. All three of these quantities, length, breadth and height, have a symbol for them in italics. (*l, b,* and *h*). But the 'unit' for all three of them is the metre. The metre has the symbol 'm', written with an upright character. There is a tendency to use the symbol of the unit instead of the more correct quantity symbol. eg "rated kVA". (kilovolt-amps). The correct way is to give a quantity (in this case, watt, symbol W), not the units for a power rating. See http://physics.nist.gov/cuu/Units/introduction.html for more explanation.

B. DIFFERENCES BETWEEN ENGLISH AND FRENCH DOCUMENTED IN 1992

The context as stated elsewhere was science, taught in French, in Tunisia. The textbooks were primarily Tunisian, but in the particular school observed, there were French science teachers and ready access to French textbooks. Some of the differences documented here may no longer exist - either in Tunisia or in France. Some of them may have been due to carelessness. Nevertheless, the differences here stand as examples that did exist and may well exist still. The way they are classified may also help readers to organise the information and be alert to the question.

1. Vector quantities

Some quantities have both a size and a direction. Such quantities are called ‘vector quantities’. This is the case for instance with force. Force in English is characterised by both quantity (size) and direction of action.

If CLS is valid then the conventions for stressing that a quantity is a vector quantity will be the same in English and in French.

In French vector quantities are indicated by is made by writing a right facing arrow above the

quantity eg $\vec{\mathbf{F}}$

Bold type can be used, or wavy underlining in handwriting, but the bold type is rarely obvious. When it comes to indicating unit vectors, Cores (1983 p94) gives '**â**', a bold symbol with a circumflex, as "unit vector in the direction of 'a' ". This is not the same as anything else mentioned so far and is little used in physics. French uses the

$\vec{\imath}$, $\vec{\jmath}$, and $\vec{k}$

convention to represent unit vectors. They are little used in English school science, and certainly nowhere near the extent that they are used in French. They are not SI so far as I know.

2. Units

Example 1, the ohm

The international ohm symbol Ω is apparently little used in English according to Maillot (1981 p216), though I would dispute that. Maillot thinks the English preferring to write out the unit in full, though the symbol does exist.

Example 2, the kelvin

In the Tunisian French texts, (up to 1988) the ^{o}K for degree kelvin was used. Maillot (1981 p218) reports that the thirteenth Conférence Générale et du Comité International des Poids et Mesures (CGPM) (1967-8) replaced the 'degree kelvin' by the 'kelvin'. In 1983 (p43) Défourneaux could still write ^{o}K. I do not know if this carelessness is widespread.

Example 3, the degree Celsius
This is an interesting unit when it comes to language change. Défourneaux as late as 1983 (p43) could write, in the French column, "20 ºC = 20 degrés centigrad" and in the English column "20 [degrees] centigrade/Celsius abbrev.: 20 C". ie no degree symbol at all. Défourneaux is not always correct. Maillot (1981 p218) points out that there is confusion in French over how to write the unit, eg is it 5 º C or 5 ºC ? The latter is apparently preferred by UIPPA (Union Internationale de Physique Pure et Appliquée) and is viewed as the reasonable solution since the two symbols go together and it is normal to separate the numerical value and the symbol of the quantity. The British though resolve the problem by eliminating the space and writing in one go, 5 ºC as did Tunisian books. This question is not even mentioned in ASE (1981) or in other publications that might be expected to deal with it, such as ASE (1985) or IOB (1989).

Example 4, the speed of rotation
As ASE (1981 p25) explains, in common use, but 'non-SI' is the unit rev/min (recommended up to 16+ in age with r/min also possible) and rev min^{-1} (for beyond 16+). The official SI unit for rotation, 'rad s^{-1} ' is international, but in English 'rev/min' and 'rev/s' (French: 'tr/min' ie tours/minute and tr/s) are commonly used.

Example 5, the minute
The symbol for minute, 'mn', is, according to Maillot (1981 p218) used with 'min', in France, even though only 'min' is technically correct. ASE (1981 p19) reports that 'min' is not part of SI, but is in general use.

Example 6, the units of pressure
This is one area where the units are difficult, and where recent changes are still being implemented.

The problem is a historical one. Medicine has used millimetres of mercury, where 760 mm Hg = 1 atmosphere. Chemistry has used either mm Hg (mmHg) or, simply, atmospheres. Physics though defines the quantity of pressure in terms derived from the seven basic units of the SI system. Pressure then has the units 'newtons per square metre', Nm^{-2}. The unit of pressure is the pascal, Pa. So 1 atm = 760 mm Hg =101325 Pa pascals = 1.01325 bar. Meteorologists use the bar, which ASE (1981 p22) says is "not a recognised unit, but still in use" especially in meteorology. Tyre pressures add to the confusion, with various units such as the old pounds per square inch (easily converted to atmospheres assuming 14.5 lb/in^2 = 1 atm), and the almost SI unit of $kgcm^{-2}$. All these are in current use. The Institute of Biology (IOB 1989 p4) recommends that the pascal and the kilopascal be used, while admitting that millimetres of mercury is still in use in medical practice. This has caused problems for textbook writers. Whelan & Hodgson (1989) state that while they used the SI system, Non-SI units have been given in addition where it is anticipated that the SI system may not be adopted in the near future.

Example 7, the Angström Å
This is a unit of length equal to 10^{-10}m and, as Longman (1985) says, is "not now recommended for technical use". But this unit was used in Tunisia. Chemists found it convenient, as it is the diametre of a hydrogen atom. The unit is obsolete, so obsolete that ASE (1985) does not even comment on it. The whole SI system beyond 1000 or 0.001 is based upon multiples of three. The nearest unit to the Angström is therefore the nanometre, nm. While the Angström for a time was a unit used in both French and English it is no longer used. So the example here is one of an old unit in both languages still being used in Tunisia.

Example 8, the calorie and the joule
The modern unit of energy is the joule. The old unit was, in certain circumstances, the calorie. The unit is a particularly difficult one to change as it has come into common use for giving the energy content of foods, and in terms such as the 'thousand Calorie diet'. The calorie was defined as the amount of heat energy required to raise 1cm^3 by one degree Celcius. Unfortunately, this amount varied somewhat depending on the starting temperature. Conveniently, there is an accepted fixed conversion rate of 4.18 joules = 1 calorie.

There is even more possible confusion, because in popular language, calorie is confused with kilocalorie. The thousand calorie diet is actually the thousand kilocalorie diet. Sometimes attempts are made to distinguish by awarding a capital C to the calorie that is actually a kilocalorie. Thus one calorie (4.18 joules), one Calorie (4180 joules).

3. Quantities

Example 1, standard pressure
Many calculations in chemistry are based upon the 'standard pressure for gases'. This used to be one atmosphere, or, since the time when the pascal was the recommended unit of pressure (ASE 1985 p12) the equivalent in pascals: 101 325 Pa. IUPAC now recommends that the standard pressure for reporting thermodynamic data be fixed at 100 000 Pa, but that 'normal boiling points' (ASE 1985 p12) should continue to be reported at 101 325 Pa as before.

The 'standard pressure for gases' is particularly used when combined with temperature: 'standard temperature and pressure (stp)'. The 'stp' is used in calculations in 'A' level chemistry upwards. This used to be in English schools 298.15K and 1 atm (ie 25 ^{o}C, and 760 mm Hg = 101 325 Pa) (ASE 1985 p14). At stp one mole of a gas occupies approximately 24 dm^3 (ie 24 litres), which is convenient for calculations. The new unit of standard pressure gives a more difficult approximation of 23.7 dm^3 as well as meaning that in English two standards for pressure in thermodynamic data exist at the same time.

In French the standard temperature and pressure are defined as at 0 ^{o}C (273.15K) and 1 atm. ('*les conditions normales*'). This would mean one mole of a gas would occupy 22.4 dm^3 and if 100 000 Pa were used, a mole of a gas would occupy 22.1 dm^3.

A different standard temperature and pressure is therefore used in Tunisian schools compared to the new 'stp' recommended by IUPAC. Two 'standards' exist within IUPAC.

Example 2, subscripts and superscripts
On this subject Maillot (1981 p216-7) has little to say. He does though raise an interesting point, without exploring it, that the way of labelling diagrams can differ in the use of superscripts and subscripts.

a) Thus German can write I_k for a short circuit current, (meaning Kurzschluss) whereas French would use I_{cc} for court-circuit.
b) The "ionic product for water Kw" whose units are mol^2dm^{-6} (ASE 1985 p10) is the "produit ionique de l'eau" symbol "Ke" in French. Therefore here is an area where CLS is not necessarily valid. At school level it is not possible to explore this subject further, other than to comment how this is yet another small area where differences exist between English and French.

Example 3, blood pressure
In the French system, in daily life and in the textbooks, blood pressure is routinely measured in centimetres of mercury, not millimetres. While the school textbook did give units when referring to blood pressure, to state the units when a pressure is given orally, in either language, is unusual, therefore this can be confusing when changing languages.

It is interesting to consider why French and English have different habits. I have done so in Key 4 point g of A Feel for Statistics. The problem is really Hobson's choice. It is a forced choice. Measuring blood pressure to the nearest millimetre is being overprecise. Measuring bloodpressure to the nearest centimetre is probably precise enough for most people, but not for all, therefore is probably not being precise enough. Here we need to be careful: the manual methods using the stethoscope and the mercury manometre required skill to operate, and even experienced people cannot consistently get good readings to the nearest millimetre - usually to the nearest 2-3mm. Modern electronic metres have taken away that problem of technique, while still leaving an underlying problem: blood pressure varies from moment to moment, and can go up or down for the most banal of reasons, including breathing, hearing a loud noise, and so on. That is why, whenever it is important, a series of readings will be taken.

It is discussing differences like these which can easily make good language practice for learners of English.

At least the custom of expressing the systolic pressure before (ie above) the diastolic is the same in French and in English.

An additional complication is that orally, in French situations, only the systolic pressure is usually given, whereas in English both the systolic and the diastolic pressures are given.

Example 4, miscellaneous
Section 2.4 of ASE (1985 p11-20) has more details about chemical symbols and quantities that have changed since the previous report in 1979. These include

a) molar entropy Sm^{Θ}
b) standard molar Gibbs energy change $\triangle Gm^{\Theta}$
c) molar mass M
d) molar enthalpy change $\triangle Hm^{\Theta}$ standard. For these and other changes too detailed and complicated to be discussed here the reader is referred to the ASE (1985) report.

The point is, that when there is language change, then problems crossing languages are likely.

4. Punctuation and forms

One of the areas which can cause difficulty, even for those working within one language, is the question of punctuation. It is a fiddly detail, and can give particular problems to examiners who may have to decide what is right and wrong. Also lack of clear agreed punctuation can lead to ambiguity.

Example 1, The decimal point and the thousands grouping

a) Different practices

Traditionally the decimal point has been in England a dot at the mid-point eg '3·7' read as 'three point seven'. Increasingly, the dot on the line has been used: '3.7' . The accepted practice in France is to use the comma to indicate a decimal, thus '3,7' read as '*trois virgule sept*'. The old English habit, which is still in wide use, is to use a comma as a spacing into three of large numbers. The newest advice is to use a half space, (which does not exist on many computer & printer setups but does exist on some old typewriters).

A reason given for abandoning the use of commas is that, By abandoning the traditional commas it is hoped to reduce the risk of confusion with the Continental use of the comma as a decimal sign. (ASE 1981 p16). This advice becomes even firmer with ASE (1985), "Commas should not be used to separate groups of three digits."(p24).

The fact remains that the use of the comma for dividing up threes used to be current practice. The use of a dot on the line can also lead to ambiguities, because this symbol also means, in French and in English, 'multiplied by'.

b) Styles of reading numbers aloud

It is well known that there are different styles of reading group numbers. For instance, with telephone numbers, not only are they traditionally grouped in three's in English and in two's in French, they are also read in a characteristic way, in groups of three but using the single digit names. The French will usually pronounce a telephone number in groups of two treating each group as a complete number. This leads to classic mistakes of comprehension, for instance 90 is read in French as 80 10 (quatre-vingt dix) and can easily be mistaken for two couplets, not one, only a slight pause differentiating the couplet 80, 10 from the number 90. There is at least one exception to the groups of three rule in English: the date 1992 is almost always read as 'nineteen ninety-two'. though in general use (not dates) 1100 can be read as either 'eleven hundred' or 'one thousand one hundred'.

Not so well known perhaps is that the same French couplet practice happens after the decimal point. eg "sixty-two point thirty-three grams" for '62.33'. This happened frequently. I have sometimes (rarely) heard this practice in English, but I regard it as non-English.

Example 2, forms of numbers
For scientific language to be international, the way of writing the symbols and numbers must be the same. In fact, the French and the English, while having the same printed styles, do not have the same styles in handwriting.

FIGURE 1. HANDWRITTEN NUMBERS

English number	French eyes	French number	English eyes
1	letter 'I'	1	seven
7	one or four	4	seven
9	one	9	eight

These variants are not just 'bad habits'. Some of them are clear stylistic differences which need to be recognised. In handwriting, numbers which are the very basis of scientific communication in symbols, are not necessarily international in form.

Example 4, organic chemistry
In Lowe 1992 Chapter 17, 'Chemical Terminology' and in my article on this site, Words in the language of Science, it has already been shown that the punctuation used in the names of organic compounds is not the same in English and French.

Example 5, position of the unit symbol in the figures
Commonly 3.6 kg is written, " 3 kg 600 " in French. Ketteridge (1983 vol 1 page LXXXiii) writes:

La denomination des poids et mesures, qui est généralement placée en français entre le nombre entier et la fraction; ainsi 1^{m},25 0^{m}m,25 suit les chiffres en anglais; ainsi or 1·25m, ·25m ou 0·25m.

(The unit, in French is generally placed between the whole number and the fraction thus 1m,25 0m25. In English on the other hand the pattern is 1·25m, ·25m 0·25m.)

Even if this is a dying French custom, it is still a significant difference between English and French.

5. **Biology**

Example 1, osmosis
IOB (1989) makes some significant remarks on this subject. Apparently the terminology of osmosis and therefore its symbols are still being worked out and standardised at school level, therefore only limited advice could be given. Therefore the terminology and symbols are not even standardised in Britain, let alone internationally.

Example 2, genetics
When drawing genetic pedigrees the system exists, which is the same in English and in French, of using a circle to represent the female, and a square to represent the male, with filled in shapes to represent an affected individual. Also the labelling of blood groups is the same.

In French and English allele pairs are represented by a capital letter for the dominant and a lower case letter for the recessive. But in French the allele pair is represented as a fraction, except where statements of proportions of a cross are used, in which case square brackets round the horizontally written pair were used.The same pattern was followed for sex linkage. Subscripts are used instead of superscripts. These differences are summarised in figure 2. below.

FIGURE 2. GENETICS SYMBOLS

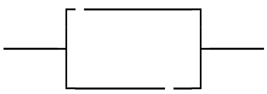
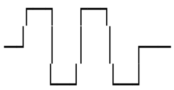
Feature	English symbols	French symbols
Representation of the allele pair	Hh	H – or [Hh] h
Sex linkage	X^HX^h	X_H – X_h

6. **Physics**

One particular area of symbols belonging to physics is the electrical symbols. This is not the place for a detailed comparison, only the differences from the school material I studied will be noted.

Example 1, The resistor symbols
The three possible symbols are as in figure 3. below, with a descriptive name added, to facilitate discussion.

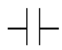
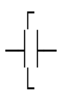
FIGURE 3. RESISTOR SYMBOLS

	rectangle
	zig-zag
	snake

The new standard is the rectangle (ASE 1981 p13). The French sources Anabac (1988b) and Corrigés (1988) both use the rectangle. The Quid (1985) uses the zig-zag and the snake. (for both on one page, in two separate diagrams see Quid 1985 p198a).

Example 2, capacitors
The standards in Britain (ASE 1981 p13, cp Symboles 1986) and both Tunisia and France (Anabac 1988a p110,)are shown in figure 4. below. The standards are clearly very different.

FIGURE 4. BRITISH AND FRENCH CAPACITOR SYMBOLS

Type	British	French
capacitor		
polarised capacitor		

7. Other symbols in Chemistry

Example 1, symbols of the elements
A comparison of the symbols used for the elements will show that they are identical in French and English.

Example 2, state symbols
These are symbols used in chemical equations to represent the state of the substance in the reaction. They are not considered to be abbreviations as such, since they are used in equations. These symbols are the subscripts as in figure 5. below.

FIGURE 5. STATE SYMBOLS

English(ASE 1985 p85)	French
(s) solid state (l) liquid state (g) gaseous state (aq) aqueous, dissolved in water	<solide>, s, sd <s>, (solution), aq

Notice the potential for confusion between s (meaning solid) and <s> meaning aqueous. Frequently, instead of state symbols, other symbols were used as in Figure 6. below.

FIGURE 6. OTHER KINDS OF STATE SYMBOLS IN FRENCH

Example	Comment
a) $\underline{PbCl_2}$ ↙	In context, means precipitate
b) ↗ Cl_2	Gas given off. This symbol was frequently used along with variants such as c) below
c) ↗ Cl_2	variant of b)
d) $NH_3\uparrow + HCl \rightarrow NH_4Cl\uparrow$	meaning gaseous

e) QR = Volume de $C0_2$ ↗ ------------------ Volume de 0_2 ↘	The upward arrow means expelled or rejected. The downward arrow means absorbed.

Example 3, ways of writing the charge on ions
In old textbooks in English one sometimes sees something frequently met here in Tunisia, but which is no longer accepted practice in British school books, namely, the use of two or more pluses or minuses for the charges on ions instead of using the number, then the sign. For instance, " O- - " instead of "O^{2-} ", and, " SO_4= " instead of SO_4^{2}- .

Example 4, dot and cross diagrams
These are a well known teaching aid for the structure of molecules. Usually two different kinds of elements are involved. In one element the electrons in the outer energy level (also called shells in the outmoded valency theory) are represented by a dot, in the other element the electrons are represented by a cross. Thus HCl can be diagramatised as as in figure 7a.

FIGURE 7a. DOT AND CROSS DIAGRAM, BRITAIN

```
   •xxx
 H xClx
    xx            (ASE 1985 p86)
```

The problem is that the Tunisian texts used dots only,

FIGURE 7b DOT AND CROSS DIAGRAM, TUNISIA

```
       . .  - -
Mg++ :O:
       . .
```

This may have been a mistake, but it was observed frequently.

Example 5, oxidation number
There is no agreed notation to express 'the oxidation number of B'. This is confirmed by the ASE who suggest "*Ox*(B)". (ASE (1985 p95).

8. Mathematics

Example 1, The division sign

These two symbols for division are constant:

$\frac{a}{b}$

and a/b.

In England the ' : ' sign means "is to, the ratio of". The French simply use the solidus ' / ', but this can lead to ambiguity. There is a huge difference between ¼ and 1:4. To use the traditional cake analogy when discussing fractions, ¼ implies that a cake has been divided into four equal parts and one of them has been taken to eat. But to divide a cake up in the ration of 1:4 implies fifths are involved, and the cake is divided into two parts, of one fifth, and four fifths respectively. 'One to four' means '1:4', but 'one in 4' means '¼'. It is easy to confuse fractions with ratio.

FIGURE 8. THE DIVISION SIGN

French symbol	French meaning	English symbol	English meaning
/	fraction eg ¼ or ratio eg 1:4	/	fraction: one divided by four
:	fraction ¼	: ÷	ratio 1:4 fraction ¼

Example 2, the algebraic value ‖‖ and the absolute value | |

There is a symbol used in French and Tunisian textbooks, to make a distinction not usually made in English. This is the ‖‖ symbol. It means, 'numeric value of'. It is used for vector quantities ie numbers which refer to something which has both size and direction, to stress the fact that the size is being talked about not the direction. The example of force will make this clear.

FIGURE 9a FRENCH SYMBOLS FOR NUMERIC AND ALGEBRAIC VALUE

Symbol	Meaning in French
F	valeur algébrique
$\|\vec{F}\|$	valeur numérique

$\|\vec{F}\|$ = a number, and is simply a way of stressing the fact that the force now has a value. It is read as 'the value of F equals'.

The symbol F alone, without vector or magnitude symbols attached means 'algebraic measure' of F. This is to make a distinction not usually made in British schools, but which comes easily to the students in Tunisia due to the kind of mathematics they have learnt.

Note, this is not the same as the distinction made in ASE (1981 p7ff) between 'quantity algebra' and 'number algebra'.

English has one symbol:| | to indicate either the operation 'the modulus of' or the magnitude of a vector quantity, where French has two:| | and ‖‖ respectively. The former means in both languages the positive value of, but in English can also indicate, when placed round a vector quantity, that the size is being referred to, whereas Tunisia insisted on ‖‖ for this.

FIGURE 9b FRENCH AND ENGLISH MEANINGS OF | | AND ‖‖

Symbol	Meaning in French	Meaning in English
| |	Positive value of	Positive value of, OR Magnitude of a vector quantity
‖‖	Magnitude of a vector quantity	No meaning

It is worth noting that while the second use in English for | |, (the magnitude of a vector quantity) exists, it is rarely used, whereas in French ‖‖ is used routinely in school physics along with vector and unit vector notation.

Example 3, identical to, ≡
This symbol in English means "is identically equal to" (ASE 1985 p24) or "is identical to" (Longman 1985). But Quid (1985 p173) has the French meaning "congru à" ie "congruent to". Longman (1985) has though a different symbol for congruent to, and gives ' ≊ '. Cores (1983) has the symbol '≡ ' meaning both, and reserves another explanation for ' ≊ ', "is isomorphic to". (p91), meaning "a one to one correspondence between two set, which preserves algebraic structure". The symbol ' ≡ ' can also mean in English, 'represents', as for instance in a list of definitions of symbols used in a formula.

Example 4, equivalent, similar, in the order of, ~
Longman (1985 symbol) explains this as "equivalent, similar" which agrees with Cores (1983 p91) which also give the extra meaning, for ~p as "not p". Quid (p172a) gives the French for <<non P>> as

$\neg p$ or $\vec{p}$

The symbol ~ does not have any meaning in the French system. Approximation up until 1990 was not taught in Tunisia, and certainly not to the extent it was taught in Britain, therefore there is no use for the distinction between 'approximately' and 'in the order of'.

Example 5, therefore and because
Extremely commonly used in English are two symbols, '∴t ' and ' ∵' meaning 'therefore' and 'because' respectively. Longman (1985) gives only the former, Cores (1983) gives neither, though both are in use in Britain. These symbols are not used in French. The symbol '⇒' would probably be used for 'therefore'. The symbol '⇒' exists in English with the sense of 'implies'. (Cores 1983 p91) as in French '*implique*'. (Quid 1985 p173).

Example 6, the angle
In English this can be written xây or ∠xay. The second style, or more simply ∠a is more common. Défourneaux (1980 p65) has the French as Â and the English as ∠a. Longman (1985) gives the symbol ∠ and Cores (1983) has no reference. To my knowledge the ∠ format is rarely used in French whereas it is very common in English.

Example 7, The set of rational numbers Θ and positive integers N
Both French and English use the symbol Θ to represent the set of rational numbers, and N to represent the set of positive numbers. But the variants are not the same. There is the question of whether or not zero is included, and with Θ how to make the set to mean positive numbers only. Figure 10. is compiled from Cores (1983 p90), and Quid (1985 p173) and gives the differences in detail.

FIGURE 10. RATIONAL NUMBERS AND POSITIVE INTEGERS

symbol	French meaning	English meaning
N	with zero	with zero
N^{+}	without zero	without zero
Θ	with zero	with zero
Θ^{+}	with zero, positive only	without zero, positive only
Θ_0^{+}		with zero, positive only
Θ^{+*}	without zero, positive only	

Particularly ambiguous is the notation Θ^{+}, which means two different things in French and English.

It is not simply a question of whether the notation exists in two languages, but a question of who uses it. Given the lesser part that mathematics plays in education in UK, the notation here is not fully international as it is not used in UK to the same extent. It would not have been understood by counterparts in Britain.

9. Indices

FIGURE 11. SUMMARY OF THE ECOLOGY INDICES

French	Possible English equivalent
abondance	frequency
dominance	density (as a density, not as a percentage)
abondance-dominance	species cover (not used in English
sociability	gregariousness

So only '*abondance*' has a direct English equivalent, and it is not a scale as such in English.

Example 2, *l'indice d'aridité de De Martonne*
Not known to exist in English.

Example 3, *l'indice d'aridité mensuel*
Not known to exist in English.

Example 4, rainfall and temperature quotient of Emberger
The French is quoted in full in figure 20.4 below. The English as used in the translation is given beside the labels of the subdivisions.

FIGURE 12 RAINFALL AND TEMPERATURE QUOTIENT OF EMBERGER (Fifth year Tunisian French biology textbook p142-3) , with translations given by the Biology teachers.

Cette formule est plus élaborée puisqu'elle tient compte, à côté de t et de p, la variation annuelle de la température.

$$Q=1000\frac{P}{t(M-m)} = 1000\frac{P}{\frac{(M+m)(M-m)}{2}} = \frac{2000P}{(M+m)(M-m)} = \frac{2000P}{M^2-m^2}$$

P= pluviosité annuelle exprimé en mm.
t= température moyenne annuelle en degré Kelvin.
M= moyenne des maxima du mois le plus chaud en degré Kelvin
m= moyenne des minimal du mois le plus froid en degré Kelvin
REMARQUE: 1_ Kelvin = 1_ Celcius +273. Ce quotient permet de classer les différents types de climats méditerranéens caractérisés par des saisons thermiques nettes et une pluviosité concentrée sur la période plus ou moins froide de l'année. Il permet également de distinguer des étages, des sous-étages et des variantes climatiques. Les étages et sous-étages sont fonctions de Q. Les variantes sont fonctions de m.

1) Les Etages:
Humide: $70 < Q$
Semi-aride: $35 < Q < 70$
Aride: $10 < Q < 35$
Saharien: $Q < 10$

	(English)
2) Les Sous-Etages	
Perhumide: $110 < Q < 150$	Superhumid
Subhumide: $70 < Q < 110$	Subhumid
Semi-aride supérieur: $50 < Q < 70$	Superior Semi-arid
Semi-aride inférieur: $35 < Q < 50$	Inferior Semi-arid
Aride supérieur: $25 < Q < 35$	Superior arid
Aride inférieur: $10 < Q < 25$	Inferior arid
Saharien supérieur: $5 < Q < 10$	Superior saharian
Saharien inférieur: $Q < 5$	Inferior saharian

Notice how the subdivisions in particular are hard to translate: superior and inferior do not fit in English. The scale is not known to exist in English, and certainly does not exist at school level.

10. Equations

The different ways of writing equations in French and English indicates not just a change in the use of symbols, but is the outward expression of a whole different way of approaching the mathematics of physics. Someone who has never used unit vectors, cannot easily appreciate the subtleties of the physics that relies upon them.

In addition, 'A' level physics does not formally require that a student knows how to integrate and differentiate (though a grasp of âx, ¢x and d/dt for rate of change is expected, AEB 1988 p302). It is inconceivable that anyone doing physics as one of the major subjects in a French or Tunisian baccalaureate would not know the basics of integration and differentiation. This is clearly a major difference in skill level expected of pupils, and it is reflected in the equations students are expected to use in French physics.

In the cases where a choice of mathematical expressions is possible, CLS would imply that the same choice would be made in different languages, for a particular level of teaching. The examples given below are not exhaustive, they are taken mainly from those met in the classroom situation.

Example 1, Ohm's Law
The usual English statement of this is V = IR, voltage equals current times resistance. Quid (p199b) gives a similar formula V = RI but the Tunisian French and English texts use the symbols u = Ri. The symbols are not the same in French and English for this law.

Example 2, Newton's Second Law of motion
The usual English expression of this law is that force equals mass times acceleration, F = ma. Whelan and Hodgson (1989 p34) also give 'force is proportional to the rate of change of momentum', as in equation one of figure 21.1 below. Equation two below was given in a summary in the French Tunisian book. It means the sum of the external forces equals the rate of change of the quantity of movement of the physical system and also equals mass times vector acceleration.

FIGURE 12. EQUATIONS OF NEWTON'S SECOND LAW

(1) English: $F \propto \frac{d}{dt}(mv)$. Whelan & Hodgson dt (1989 p34)

(2) French: $\sum_{i=1} \vec{F}(ext)\vec{i} = \frac{dp}{dt} = M\vec{\gamma}$

It is probable, because the English version of the equation is simpler than the French version, that those used to the French would be more likely to understand the English than vice versa. The English equation is considering one force, the French equation is considering the sum of the external forces. The equations are comparable, the French equations being more complete.

Example 3, motion equations

FIGURE 13. MOTION EQUATIONS IN ENGLISH

v = final velocity
u = initial velocity
a = acceleration
t = time
s = distance travelled

(1) $v = u + at$

(2) $s = \frac{u + v}{2}.t$

(3) $s = ut + ½at^2$

(4) $v^2 = u^2 + 2as$ (Whelan & Hodgson 1989 p29)

FIGURE 14. MOTION EQUATIONS IN FRENCH

(5) $v = \gamma t + V_0$ = (1)

(6) $x = ½ \gamma t^2 + V_0 t + x_0$ = (3)

(7) $vA^2 - vB^2 = 2 \gamma(xA - xB)$ = (4) (6FP53)

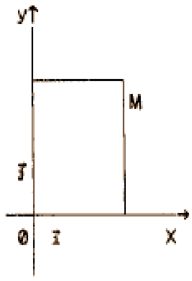
v = final velocity
V0 = initial velocity
γ = acceleration
t = time
x = distance travelled
$v_A - v_B$ = change in velocity between A and B
$x_A - x_B$ = distance between A and B

It can be seen that the equations in English look much simpler. Some of the symbols have changed. But these summary equations conceal a much more complicated situation, which is discussed in example four below.

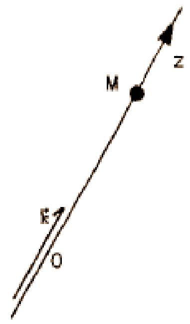
Example 4, unit vectors and motion equations

Unit vectors have been mentioned several times. The real complexities of their use is best illustrated from a worked example question. It is not necessary to understand the mathematics involved to appreciate that this level of complexity is not required for physics 'A' level. The worked example taken from the French text (6FP19) was translated by the teachers at the English school (6EPi14) and concerns rectilinear motion. The material comes from the beginning of the sixth year text, which goes on to study velocity vectors and acceleration vectors for both rectilinear and circular motion. As such it is by no means one of the more complicated examples, but is sufficient to illustrate the complexities of the French system.

A moving body, in a system $(O, \vec{i}, \vec{j})$, has a space vector $\vec{OM} = x\vec{i} + y\vec{j}$; with x = 3t and y = 4t	
1°) Give the trajectory equation in the system $(O, \vec{i}, \vec{j})$ Deduce its nature	$\vec{OM} : \{ x=3t, y=4t$ By eliminating t from the two equations we get: y = (4/3)x The trajectory is then a straight line passing through the origin.
The cartesian equation of the trajectory is a relationship between x and y.	



2°) Write the expression of the space vector in the system $(O,\vec{k})$ ($\vec{k}$ a unitary vector is held by the trajectory) and give the equations of the motion	In the system $(O,\vec{k})$ the space vector can be written as: $\vec{OM} = \lVert\vec{OM}\rVert.\vec{k}$ $\lVert\vec{OM}\rVert = \sqrt{x^2 + y^2}$ $= y\sqrt{9t^2 + 16t^2}$ $= \sqrt{25t^2} = 5t$ $\lVert\vec{OM}\rVert = 5t\vec{k}$ In the system $(O,\vec{k})$ the abscissa of M is then z = 5t. It is the motion equation.



11. Miscellaneous

a. The periodic table

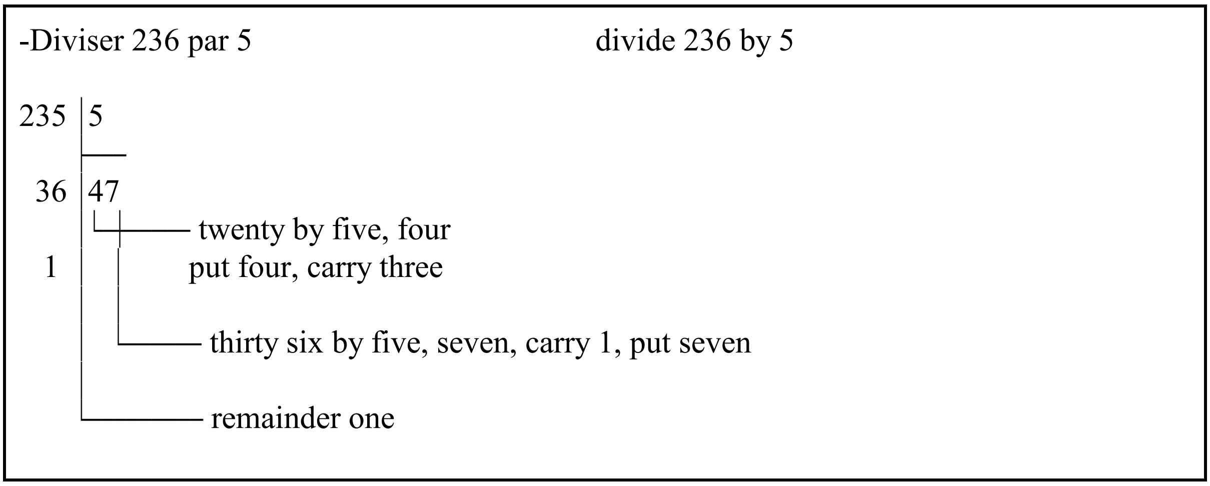
When the versions that exist of the periodic table are compared, the main point of difference concerns the noble gases. Modern British practice is to label them as Group 0 (zero). (ASE 1983 p21-3). The Tunisian books (eg 5FC140) used *Colonne VIIIB* (column VIIIB).

This is hardly a very important difference between English and French, especially as both names are known in English. ASE (1983 p21-3) has a discussion of the changing practices of labelling, and the differences between Britain and America. A new system of numbering from 1-18 is also suggested. The example then more properly belongs to the heading of language change in English and French and is an example of how change is working the same way in two languages.

b. Long division

French and English have two different systems. This fact was not accounted for by Défourneaux (Défourneaux 1980 p34) who gives the French format and English wording for it. Défourneaux is quoted in full in figure 15. below to show how different the forms are:

FIGURE 15. LONG DIVISION THE FRENCH WAY



(Défourneaux 1980 p34. The English wording given by Défourneaux makes more sense if "by" is understood as 'divided by'.)

But giving an English translation of wording used in long division makes little sense as the format of the symbols used is not English.

FIGURE 16. LONG DIVISION THE ENGLISH WAY

47 r. 1	forty-seven remainder 1
5 | 236	fives into 23 go four, remainder 3
20*	
36	fives into 36 go seven, remainder 1
35*	
1	

(Optionally a short multiplication table may be compiled as follows:

4 | 20*	four times five equals 20
7 | 35*	seven times five equals 35)

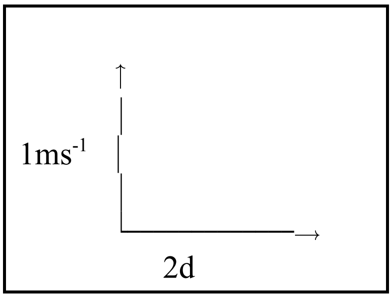
(* The stars refer to intermediate steps).

The two ways of writing the non-verbal forms of long division in English and French are evidently very different. Note also the way that the French way requires more mental effort in that intermediate steps (starred in figure 16. above) are omitted in French.

c. Labels on the axes of graphs and the indication of scale The statements of guidance for schools in UK include ASE (1981), ASE (1985) and IOB (1989). The consensus is that at the upper school level: 1) the quantity is to be stated alongside each axis, 2) the units are adjacent to the quantity, and separated from them by the solidus, 3) the divisions of the axis line are to be numbered. The scale is usually implied by the labelling of the axes.

To take the example of a problem in which a graph of velocity against time is required. The British convention would be to label the x axis ' $v/m.s^{-1}$ ' and the y axis ' t/s '. The Tunisian custom was to label the axes using brackets round the units, instead of the solidus. This would be understood in Britain but is not the accepted UK convention. (IOB 1989 p5). The French Anabacs also used the brackets round the units convention or used the word 'en' meaning 'in' eg "t en 10^{-3}s" (Anabac 1988b p99).

FIGURE 17. A FRENCH WAY TO INDICATE SCALE



This is easily understood, but is not the British way, which is to indicate scale by the divisions on the graph. The position of the scale on the graph does not appear to be constant (Anabac 1988b p98,113). I never saw the old English convention of writing scale using the 'represents' symbol, eg 1 cm _ 4s and as this symbol ' _ ' appears not to be standard or known in French, this old English custom is unlikely to exist in French.

Widdowson, in explaining his ideas that science is a universal language specifically in the area of . . . graphs charts, conventionalised diagrams, and so on which take the same form irrespective of the verbal context in which they occur. (1979 p42).

All three instances documented above are evidence against his assumption. But of the three instances, the one of most significance is probably that of the labelling of graphs. The school standards in English are those of the working scientist, when material is published in journals for instance. They are completely different to the standards used in French at school level.

C. DISCUSSION

Upon investigation it has been shown that symbols are not necessarily constant between French and English and that even where they are, it does not imply that if pupils in one language know and use them that their counterparts in another language will be similarly knowledgeable.

With the SI system, the problem is not that as a system it is failing, but that in certain areas such as pressure, and units of rotation, there is a failure to implement it completely. When there is this failure, each language may have a different notation.

The differences between French and English do not only come from different verbal expressions of a concept, but also from different accepted practices. There is also the problem of standards not being strictly maintained. Like it or not, scientists need to be able to cope with lax standards, and where lax standards differ between French and English CLS is failing. CLS also fails in assuming that symbols and standards are fixed and are not changing. Even here, in the topic of symbols which is at the heart of CLS, it is clear that the standards are still being set, and even when they have been set, their general acceptance in science education is still being negotiated.

Zylbersztajn (1983) had an interesting framework for understanding school science in relation to the science of the scientist. He argued that curriculum planners take the ‘science of the scientist’ and we have ‘science of the curriculum’. In turn, teachers, when they prepare their lessons turn this ‘science of the curriculum’ into the ‘science of the teacher’. Students start with their own ideas as children (‘science of the child’) and under the influence of the ‘science of the teacher’ in the context of the classroom develop ‘science of the student’.

To use Zylbersztajn's framework (1983), a symbol may be internationally recognised at the level of 'science for the scientist'. But if pupils in one language at a similar stage in learning do not use this symbol, then the symbol is not international at the level of 'science for the student', because it will not be understood by the counterparts in another language.

Indices give several problems for CLS. The examples above are ones which are known in French, but not in English, and even if they are known by experts, they were still not known by the small group of teachers who had to translate them. With reasonable confidence it can be stated that if these teachers did not know the index, then it was not known at school level in England, therefore scientific language is not constant, at least at school level.

With several of the indices went the problem of how to translate an eponym that was not known in English, and whether to leave the symbols in the index as the initial letters of French but not English words, or, as happened above, to change them for suitable English symbols. The problem of labelling the subdivisions was particularly difficult. If CLS were valid, then the vocabulary of subdivisions would transfer easily between French and English. In example two, the aridity index of Martone, the French dominante and exclusive were translated by 'mainly' and 'exclusively', which are passable translations, there being no known standard equivalent in English. Emberger's quotient, example four, gave greater problems, supérieur and inférieur do not translate well as 'superior' and 'inferior' even though these terms are used in the senses of 'above' and 'below' in anatomy.

Indices are not necessarily constant, neither in their name, their formula, or in the labels given to the various parts of the index.

Some equations differ between English and French, either in their symbols, or in their format, or in both. a. There can in some cases be more than one way of expressing a rule mathematically in physics. It is not necessarily true that at the same level in school, the same choice will be made as to which expression to teach, or which one to use most frequently. b. The symbols used in formulae are not necessarily the same. c. The format of an equation is not necessarily the same, even given a similar choice of expression. (eg example 3, motion laws). Vector notation, unit vectors and additional symbols add to these differences.

References

The traditional way is to only include references that are included in the article. However, since this article is an extension and selection of my thesis, for the sake of convenience, I have provided the reference list in full. Tunisian textbooks are listed at the end.

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TEXTBOOKS IN FRENCH USED IN THE ENGLISH AND FRENCH SCHOOLS

The official Tunisian textbooks in French have been referred to in the thesis by a coding and are listed here with their authors: {year number} {language} {subject} {section, if any} {page number}. F = French. E = English. B = Biology. C = Chemistry. P = Physics. M = Mathematics.

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