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## Scientific concepts and terminology in Welsh

### Introduction

In a 2013 blog post, US-based associate professor of biochemistry, Dr Steve Caplan, discussed the value of writing doctoral theses and coining scientific terms in languages not widely used in scientific research papers.

At university, not only is [introducing new Hebrew terms] no longer practical, but it also becomes a barrier. Lectures by international scientists are always in English. Graduate students need to be trained to read, write and talk in English. [...] The "translation" of highly technical and super-specialised scientific terms to artificial Hebrew expressions serves little purpose in the fight to keep Hebrew from eroding [...] since they are used by such limited parts of the general population, they will never catch on. [...].<sup>1</sup>

Like many criticisms of language revitalization, an apparently reasonable argument is built on fallacious premises. Highly specialised terms are no more 'artificial' in one language than another: all have been coined at some time and used subsequently to communicate a concept. A class of academics interacting through English will manifestly have an erosive effect on a small language community, in the same way as for any other social group. And competence in English is not necessarily impeded by mastery of terms in another language; this is true even in the context of Hebrew, but is especially obvious in other cases, like Welsh, where speakers overwhelmingly have native-like English competence.

The shift in continental Europe towards English-medium teaching in higher education, and the importance of maintaining competence in national languages in all domains, were the focus of recent conferences in Athens (2013), Tallinn (2011) and Ljubljana (2009). Against that background, this paper examines Welsh-language scientific term standardization at university level. It discusses interesting challenges in the field of chemistry, in which there has not been a strong tradition of teaching through the medium of Welsh.

### Developing Welsh scientific terminology

Modern attempts to develop Welsh scientific terminology began in the 19<sup>th</sup> century, with scientific essays in the Welsh press aimed at a large monoglot reading public. Wales's nonconformist religious majority was excluded from English universities until 1828, and Wales had no university until 1872. There was therefore no tradition of university-level science in Welsh, and inconsistent, poorly formed terminology was often used. Despite this there were some notable contributions, including scientific articles in the 10-volume Welsh encyclopaedia published between 1854 and 1879<sup>2</sup>. Welsh scientific writing declined in the first half of the twentieth century, due to the imposition of English-medium education in schools and universities, but has revived subsequently with the expansion of Welsh-medium education.

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<sup>1</sup> S. Caplan. *Tongue-tied? Perspectives on English as the international language of science*. The Guardian. 30/01/13 <<http://www.theguardian.com/science/occams-corner/2013/jan/30/english-international-language-science>> [Retrieved 24/02/14].

<sup>2</sup> J. Parry (ed). *Y Gwyddoniadur Cymreig (Encyclopaedia Cambrensis)*. Denbigh: Gwasg Gee. 1854-1879.

In 1993, work started on Welsh language terminology standardization for use in the National Curriculum in Wales, with the first terminology dictionary for schools published in 1998<sup>3</sup>. From the outset, the ISO family of terminology standards were followed, but limited space precluded the inclusion of definitions in the published dictionary. Instead, disambiguators differentiated homographic terms expressing different concepts.

2011 saw the establishment of the Coleg Cymraeg Cenedlaethol<sup>4</sup>, a virtual pan-university Welsh-medium college. This led to greater teaching of science in Welsh, and hence an increased need for term definitions. Publication had moved online, making it possible to satisfy this need: space was no longer an issue.

### Collaborating with subject specialists

As ISO standard 15188 states, involving subject specialists in the standardization of terms improves terminological quality, whilst also ensuring the implantation and dissemination of those terms.<sup>5</sup> An approach based on collaboration and consensus between subject specialists and terminologists has been extremely successful in Wales in the past, and continues in the current national Welsh Higher Education Terminology Project. Nowhere is this more in evidence than when standardizing scientific terms.

University lecturer subject specialists are supported by one terminologist. Work takes place in Maes T, an online ISO standards-compliant language-neutral concept-based terminology standardization system. The subject specialists input English chemistry terms and draft definitions. Prior to proposing candidate Welsh terms, the terminologist translates the definitions to Welsh. This brings to light the first challenge.

In translation, ambiguities in the English phrasing used by chemists become apparent. Therefore, both parties discuss the exact meaning of the concept and redraft the definition together to improve clarity. For example:

- amide** An organic compound *containing the functional group CONH<sub>2</sub>*. Amides may be primary (RCONH<sub>2</sub>), secondary (RCONHR<sub>1</sub>) or tertiary (RCONR<sub>1</sub>R<sub>2</sub>) depending on the number of substituted hydrogen atoms on the nitrogen.
- primary amide** An organic compound that *contains the functional group CONH<sub>2</sub>* e.g. ethanamide.

(emphasis added). From these definitions, it was unclear to the terminologist how 'amide' differs from 'primary amide', and why secondary and tertiary amides have formulas which do not include the symbol H<sub>2</sub>. Discussions revealed that in the first definition, but not the second, the wording “functional group CONH<sub>2</sub>” was meant to include compounds where the H atoms had been replaced by other things, (R<sub>1</sub> and R<sub>2</sub>). Other professional chemists would realise this, but students may not. The first definition was rephrased:

- amide** Any organic compound containing an O=C-N group. Amides may be primary (RCONH<sub>2</sub>), secondary (RCONHR<sub>1</sub>) or tertiary (RCONR<sub>1</sub>R<sub>2</sub>)

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<sup>3</sup> D. Prys & J.P.M Jones. *Y Termiadur Ysgol: Standardized Terms for the Schools of Wales*. Cardiff: ACCAC. 1998.

<sup>4</sup> <<http://www.colegcymraeg.ac.uk/en/theColeg/>>

<sup>5</sup> ISO 15188:2001. *Project management guidelines for terminology standardization*. (Section 4.3.4.)

depending on the number of substituted hydrogen atoms on the nitrogen.

Thus, the specialist-terminologist interaction resulted in a more precise definition. Rather than creating communication barriers as presumed by Caplan, the cross-lingual terminological process has aided communication of the concept to students, both in Welsh and English.

During the definition-writing stage, a second challenge often arises. Many definitions contain as-yet unstandardized related terms. For example, before publishing the standardized and defined term below, new related terms (underlined) must be defined and standardized first. Thus terms are often published in interdependent clusters.

**macrocycle**      Any organic compound which contains a ring of nine atoms or more, e.g. a crown ether. Macrocycles are also considered to be cyclic macromolecules.

Following definition, Welsh candidate terms are proposed for consideration. It is here that chemistry nomenclature, with its own syntax including numbers and symbols, creates a third challenge. Multi-word equivalent terms in Welsh must maintain a potentially unnatural word order to match the sequence of numbers. For example, 'alpha(1->4)glycosidic bond' becomes 'bond glycosidaidd alffa(1->4)', with reordering obscuring the 1->4 connection. A workaround, changing the term's structure in both languages, forms a single hyphenated word, 'alpha-1,4-glycosidic' / 'alffa-1,4-glycosidaidd', acceptable in both languages.

Other problematic concepts included a set of adjective phrases, each derived from a noun phrase which itself contains an adjective. These describe shapes of molecules, e.g. 'pentagonal pyramidal'. The combination of two '-al' endings makes the English terms grammatically ambiguous: what qualifies what? Discussions with the subject specialists revealed an oddity: 'pentagonal pyramidal' describes something which is 'like a pentagonal pyramid', i.e. the second '-al' operates on the whole phrase 'pentagonal pyramid'. In Welsh, the word order would reverse, leaving the equivalent suffix '-aidd' awkwardly in the middle of the whole term to which it applies. The solution chosen was 'pentagonobyramidaidd', with 'pentagonal' appearing as a prefix. Note the same structure is possible in English ('pentagonopyramidal'), and would be less ambiguous than the commonly-used term.

Previous analysis shows that, where a Welsh term is more precise than the English equivalent, students understand a geometric concept better in Welsh.<sup>6</sup> This contradicts Caplan's assumption that departure from English impairs scientific communication.

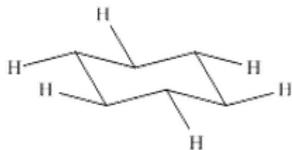
Finally, technological enhancements were made to include and index rich-text features such as italic letters, subscript, superscript, equations and diagrams in dictionary entries. Such features are included via a subset of HTML tags and web-based APIs. Diagrams are uploaded to a media library and the <img> tag used within definitions. Equation images are generated on demand, using Google's Chart API, from mathematical formulas expressed in the TeX format widely used in academic papers.

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<sup>6</sup> D.V. Jones. 'Words With a Similar Meaning,' *Mathematics Teaching 145*. Derby: ATM. 1993. ( pp.14-15.)

#### **bond cyhydeddol ans** equatorial bond

Mewn *cylch chwe chymal* sydd â *chydffurfiad cadair*, megis cylchohecsan, bond ag atom hydrogen sy'n gwneud ongl fach gyda phlân cyfartalog y cylch. Yn y diagram, mae plân cyfartalog y cylch yn llorweddol, felly mae'r bondiau cyhydeddol yn ymestyn yn llorweddol.

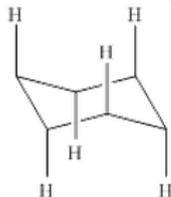


*In a six-membered ring with a chair conformation, such as cyclohexane, a bond to a hydrogen atom that makes a small angle with the average plane of the ring. In the diagram, the average plane of the ring is horizontal, so the equatorial bonds extend horizontally.*

*Geiriadur Termau Cemeg*

#### **bond echelinol ans** axial bond

Mewn *cylch chwe chymal* sydd â *chydffurfiad cadair*, megis cylchohecsan, bond ag atom hydrogen sy'n gwneud ongl fawr gyda phlân cyfartalog y cylch. Yn y diagram, mae plân cyfartalog y cylch yn llorweddol, felly mae'r bondiau echelinol yn ymestyn yn fertigol.



*In a six-membered ring with a chair conformation, such as cyclohexane, a bond to a hydrogen atom that makes a large angle with the average plane of the ring. In the diagram, the average plane of the ring is horizontal, so the axial bonds extend vertically.*

*Geiriadur Termau Cemeg*

7

## Conclusion

The standardization of Welsh scientific terms raises a number of interesting challenges peculiar to the language of chemistry. These can be overcome through collaboration between terminologists and subject specialists.

Caplan's concern is that the use of a national language in advanced science creates barriers to communication and harms students' English skills. This paper, however, has indicated that reserving space for a national language in higher education, along with the appropriate terminology resources, may benefit students' understanding and ability to articulate concepts in all languages.

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<sup>7</sup> <[www.colegcymraeg.ac.uk/termau](http://www.colegcymraeg.ac.uk/termau)>

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