Simplified or erroneous? It's a fine line (Note †)

Novice learners need to have simplified explanations because they are unable to understand fuller, more-involved explanations. However, there is a dangerously thin line between simplified explanations and over-simplified erroneous explanations, which lead to later misunderstandings and misconceptions.[2] It is harder to unlearn misunderstandings and misconceptions, than to learn something new ab initio.[3,4] Consider the following two examples of over-simplifications.

The ^{1}H-NMR spectrum of ethanol is often used as an exemplar, because the ethanol spectrum,[5] without spin-spin coupling, was the first example of an intramolecular chemical shift and was featured in the 1952 Nobel lecture.[6,7] Textbooks state that protons separated by 3 bonds (H-X-Y-H) have splitting in the ^{1}H-NMR signals. The textbook version of the ethanol spectrum, intended to illustrate spin-spin coupling, does not show any splitting associated with the CH_2-OH coupling. These textbooks state that in the alcohol CH_2-OH moiety, protons separated by 3 bonds (H-C-O-H) mysteriously do not have this splitting. This myth is so entrenched, that it has been implemented in empirical and semi-empirical rules for the prediction of NMR spectra.[8] The non-appearance of the CH_2-OH coupling is due to impurities in the solvent, which, even at extremely low concentrations, can participate in intermolecular proton exchange with the OH group.[9] The CH_2-OH splitting in alcohols is clearly seen when solvents without trace impurities are used.[10,11] Lack of knowledge of a chemical reaction from later in the curriculum, leads to misconceptions and confusion as to when protons separated by 3 bonds do or do not have spin-spin coupling.

In another example, students are taught that a complete list of reagents and equipment must be listed in the report of an experimental investigation. In some cases, even the paper towels used to wipe up spills are listed, contrary to conventional practice in industry, research institutions and academia. Publishers often combine the experiment instructions for teachers, laboratory staff and students into a single document,[12,13] so that teachers and students are uncertain what information is intended for which readership group, and they are confused about what information should be included in the student report. When in doubt, the desire for completeness dictates that more information is better than less; completeness and confusion conquer chemical convention.

It is virtually impossible for any teacher to know everything that students will need for future study and careers, as each subject will lead to a myriad of pathways. For example, in my undergraduate 1st year class, students will go into numerous majors across more than 16 degree programs ranging from arts to zoology and from engineering to food-and-nutrition. The present subject is part of the foundation for many possible pathways, but it is extremely difficult for a single teacher to know about all of them, or to know about specialist topics developed in later years. Thus, to prevent over-simplifications and misconceptions, there is need for partnerships between the teacher in the present subject and employers, researchers, industrial scientists and teachers from later in the educational and career pathway. These vertical partnerships or advisory groups can help teachers to access information from later in the pathway, so that these teachers have a greater appreciation of the subtleties and the whys of what they teach. Not everything is in the textbook. Indeed, this in implicit in the new National Curriculum, in which students have to learn about the culture of science as part of Science as a Human Endeavour (SHE).[14] We need more partnership and cooperation between the teachers, who are pedagogy specialists, and researchers and industry scientists, who are the content knowledge specialists.[15]

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1 K. F. Lim, “Simplified or erroneous? It’s a fine line”, *Chem. Aust.,* 2013, **2013 (July)**, 35.
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