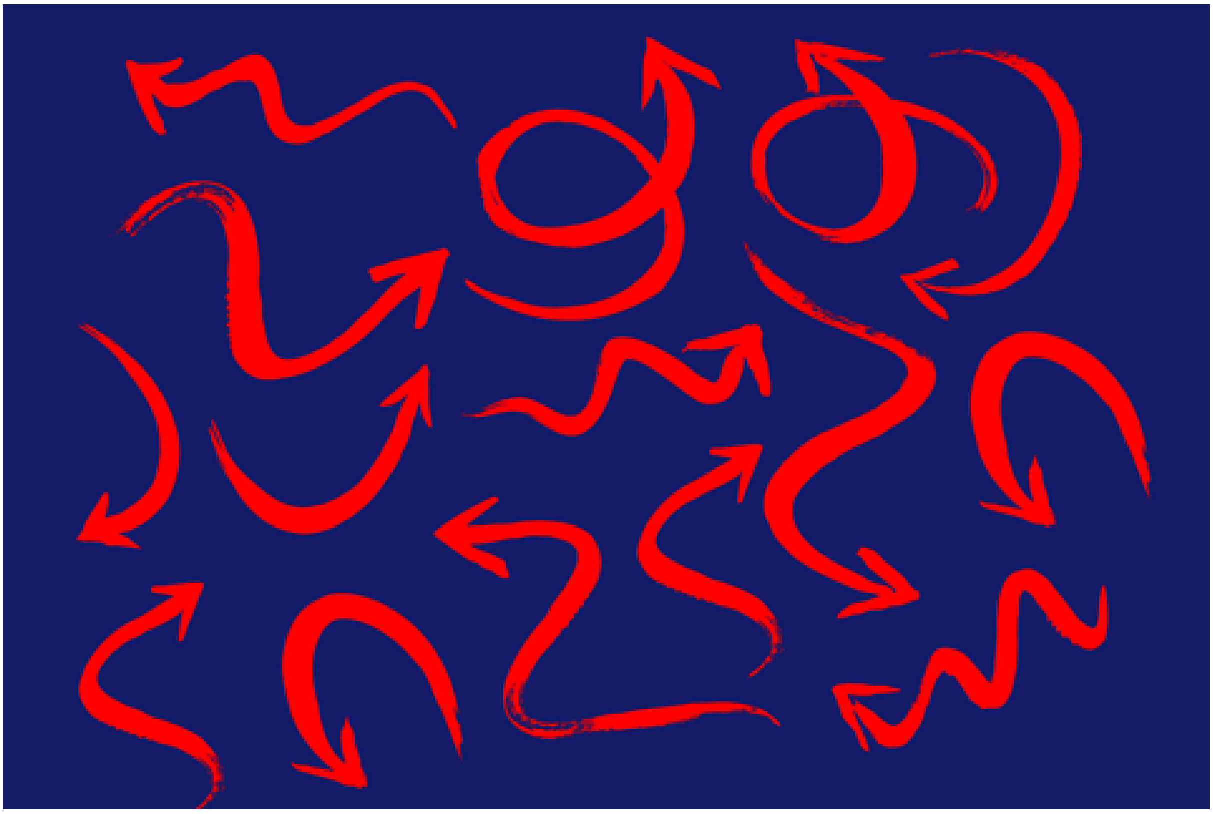
education in chemistry

Organic archery

By Fraser Scott | 28 April 2020

A free, online resource for teaching organic chemistry gets a positive evaluation

Chemistry is packed with



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A new study shows the OrgChem101 online resource can help students master curly arrows

representations that describe unseen phenomena. One example is the electron-pushing formalism within the language of organic chemistry. Here, curly arrows represent the flow of electrons during a reaction, beginning at non-bonding electrons, or electrons in a bond, and pointing towards an electron-deficient atom.

Educators at the University of Ottawa in Canada have previously developed an open access, online module called Organic mechanisms: mastering the arrows. It supports students' fluency in the electron-pushing formalism. The module was designed based on an extensive literature review and new research, which involved analysing thousands of typical mechanistic questions and the ways students tackle them.

Significantly, this module teaches students strategies found to be successful. For example, one advantageous method is the mapping strategy, where students label carbons in the chains of reactants and products with numbers. This helps them to compare the structures. The module also develops metacognitive skills to help students identify what they currently know, what they need to know and how to plan their learning.

Hitting the bullseye every time

In a new study, the Ottowa-based team assess the effectiveness of their online module in the context of a single, hour-long session. In particular, they focus on whether students are better prepared for two types of question: questions that ask students to draw the arrows, given the starting materials and products of a reaction step; and questions that ask them to draw the products, given the starting materials and electron-pushing arrows for that step.

The study participants were first years on chemistry-focused degrees. They worked through the online material either individually, in pairs or in small groups. An additional cohort of students who did not use the online module served as a control.

The researchers, led by Myriam Carle, used pre- and post-testing to measure the change in student performance on organic chemistry questions. They gleaned additional information through analysing students' problem-solving strategies and frequent errors.

The study found that students who used the Mastering the arrows module had significant learning gains. Moreover, these students used effective problem-solving strategies more frequently.

Teaching tips

- Try using the Mastering the arrows module, found at OrgChem101.com, to help students enhance their skills in organic chemistry mechanisms. Learning gains were observed after only one hour, so this should be relatively simple to incorporate. You can use the module in a class setting, where you can guide students through the content, or give it to students to work on independently.
- Remember that modelling of any effective strategy is worthwhile; the learning module teaches strategies shown to be successful for organic synthesis problems, and the study shows this helps students.
- Focus on strategies that help students avoid mistakes, such as answer-checking strategies. The study revealed some of the most common errors students make: missing bonds and missing atoms or functional groups were prevalent, for example.

- Try encouraging students to simply redraw reactants closer together or in a better orientation first. More errors were associated with questions with longer arrows, which suggests students have difficulties connecting structures or species that are further away from each other.
- Mastering the arrows forms part of a larger suite of modules on the website, such as Organic nomenclature and Acid—base reactions. You may find these useful to incorporate into your practice too.

References

M S Carle, R Visser and A B Flynn, *Chem. Educ. Res. Pract.,* 2020, **21**, 582 (DOI: 10.1039/c9rp00274j)