Organic Chemistry through Visualisation

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The Multi-Dimensional Nature of Chemistry

The multi-dimensional nature of Chemistry makes it a difficult topic to teach, learn and understand (Johnstone 1991, Mahaffy 2004). If we list the multiple repesentations of water, is it any wonder students become confused by represtenations?

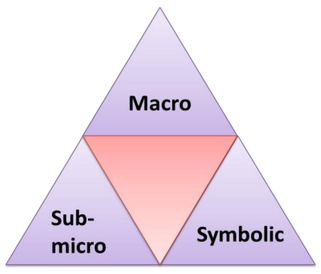


Fig 1: Triangle of Chemistry (Johnsone 1991)

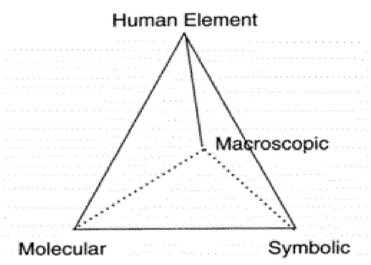


Fig 2: Learning Tetrahedron (Mahaffy 2004)

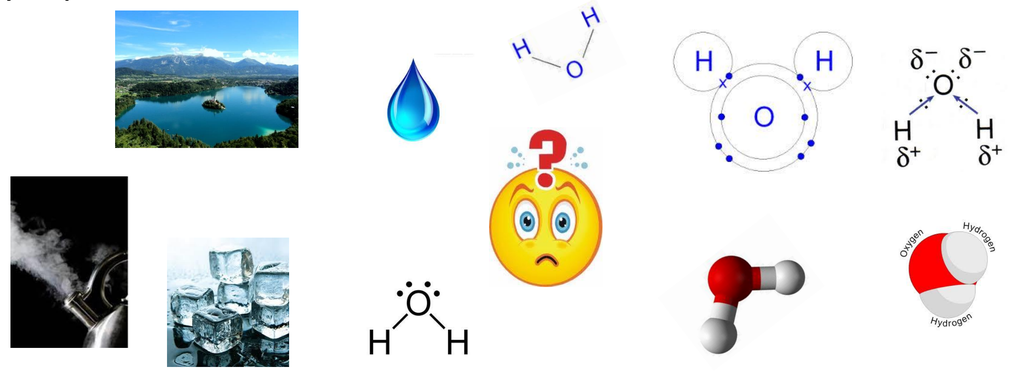


Fig 3: Multiple representations of water that can lead to confusion

The variety of representations of organic formulae and structures in Organic Chemistry hinders their understanding of core Organic Chemistry concepts (Taber 2002, Johnstone 2006, Anderson and Bodner 2000).

Aim

Develop and evaluate a 3-dimensional guided-inquiry oriented approach for teaching Organic Chemistry at 2nd Level, Senior Cycle to promote students' ability to

- inter-relate between different representations of organic molecules.
- predict physical properties of organic molecules
- predict reactivity of organic molecules

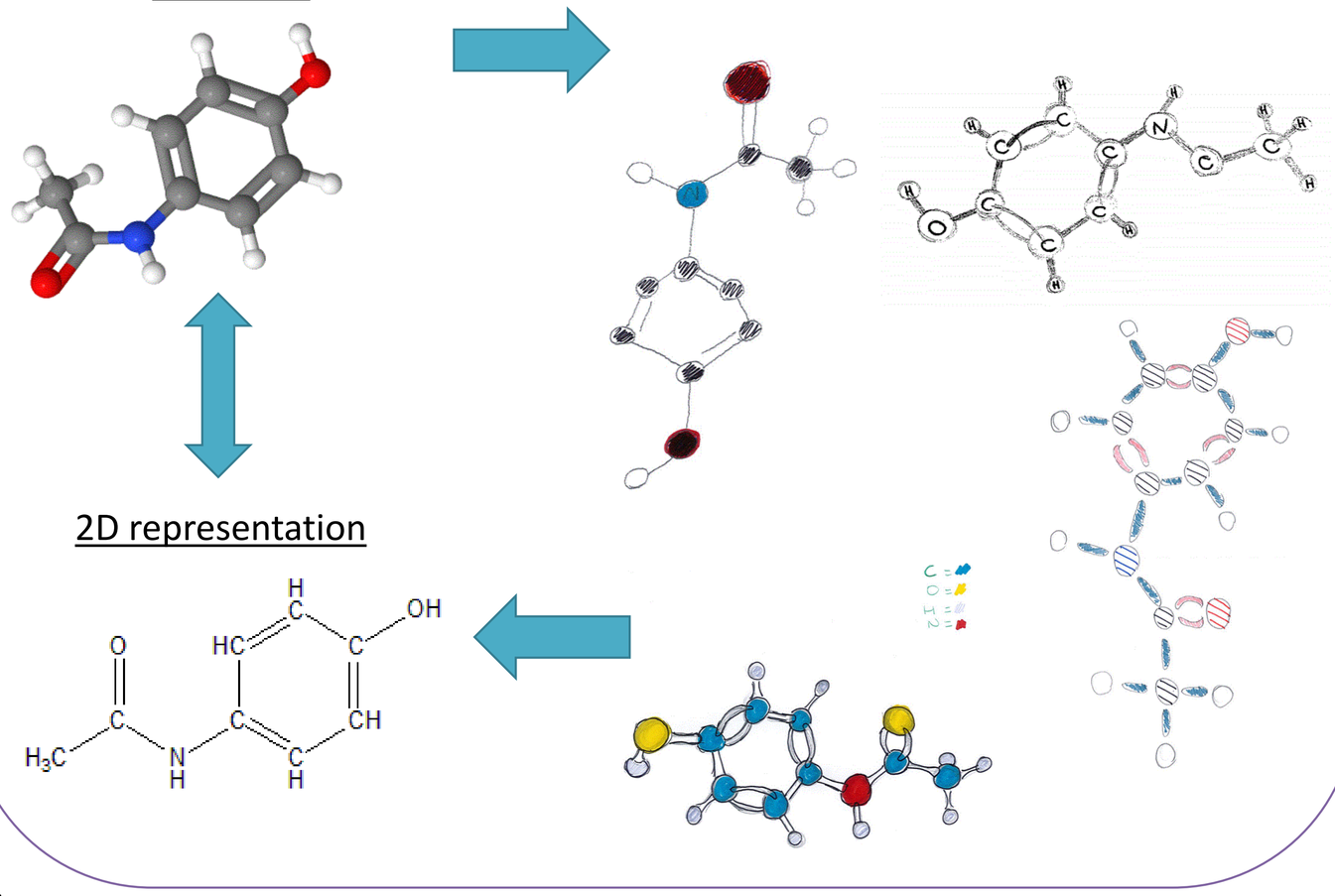
Outline of Teaching Resources

Key criteria: Facilitating inter-relation between 3D and 2D; Teaching through molecular models; Use of complex molecules; Use of everyday examples

	Concepts
Part A	Modelling and visualisation of organic molecules
Part B	Predicting and comparing physical properties of organic compounds
Part C	Predicting reactivity of organic molecules

Inter-relating between the 3D and 2D

3D Model → Student Drawings



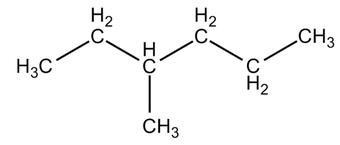
2D representation

Preliminary Results

Initial results and feedback from teachers of 6 pilot 5th year classes:

Positives	Potential Barriers
Engaging hands-on approach	Modelling is time consuming
High level of student engagement	Not enough exam focus
Pace of lessons	Initial cost of models
Clear learning outcomes	

Students were assessed using a pencil-and-paper test that contained both 2D structures and pictures of 3D models. Q2 asked students to draw 2 isomers of the following molecule:

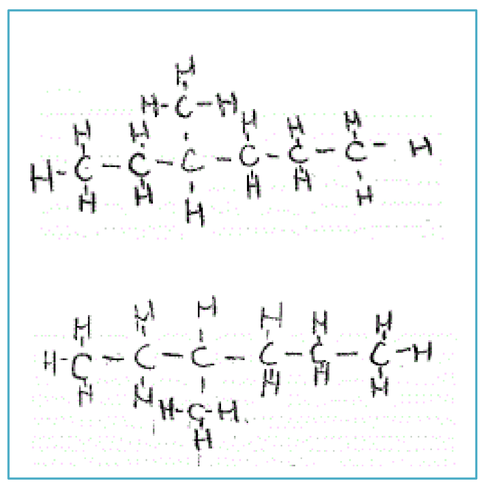


Follow-up interviews with students who answered this incorrectly by drawing the same structure with different orientation found that students could actually identify different isomers of this molecule when:

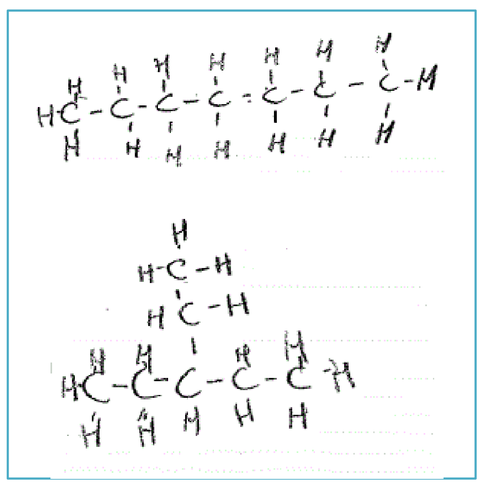
- Students were given 3D models to work with
- Students were not asked for 'isomer' but a different molecule ; indicating a misunderstanding of language

Student Example:

Isomers drawn without models (initial paper test)



Isomers drawn with models (during interview)



Future Work

- Evaluate teaching resources
- Is there a relationship between spatial ability and success in Organic Chemistry?

References:
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Johnstone, A. H. (1991). Why is science difficult to learn? Things are seldom what they seem. *Journal of Computer Assisted Learning, 7*, 75-83.
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