Reasons to Include Hands-On Learning into Your Lectures

Chemistry and indeed most sciences can be described as a complex network of models supported by a foundation of theoretical understanding. In short, models are structured representations which describe larger sets of phenomena. Therefore, in teaching chemistry, a primary objective should be the development of modeling skills in students. In fact, **the literature firmly supports that the use of models and other forms of active learning are more effective than the traditional "stand and deliver" methods that predominate in the classroom in order to foster learning** (1-5)**.**

Active learning is defined as a teaching strategy where students are engaged in interactive activities which promote conceptual understanding and synthesis of course content. In the largest and most comprehensive meta-analysis of undergraduate STEM education ever published, researchers at the University of Washington found that the use of active learning techniques unilaterally increased student test scores by 6% (1). Furthermore, this study (published in PNAS) found that **students instructed by traditional lecturing were 1.5 times more likely to fail than those taught with active learning methods** (1).

The use of models in didactic settings are regarded by scholars as inducing interactive engagement, which is an active learning concept whereby students engage in hands-on activities as a vehicle to promote conceptual understanding. Interactive engagement is a highly effective tool for increasing learning within student populations ranging from elementary school to the university level (2, 6). **Students which engage in hands-on learning techniques' such as the construction of physical models have demonstrated a quantifiable increase in learning as demonstrated by up to 12% higher test scores when compared to traditional methods** (7-9)**.** Furthermore, hands-on learning is more effective in driving student retention (10) and even in fostering positive attitudes toward the sciences (7, 10)!

We have designed our molecular modeling kits on the basis that the use of science kits has been demonstrated to be very effective in driving learning in science curricula. In a study reporting on the science achievement of students, students who are taught through science kits outperformed students without (11, 12). Moreover, **the use of science kits was equally effective at increasing test scores over students taught with traditional methods regardless of teacher training** (11)**.** This demonstrates the robustness of science-kits as an adjuvant to science curriculum.

These data can, at least in part, be explained by embodied cognition which is the concept that physical experience influences understanding (6, 13). **The act of recalling memories, reasoning**

and making inferences require the activation of sensory and motor systems (6)**.** Thus, the construction of models enhances knowledge recollection and reasoning.

Our molecular model kits are highly versatile, durable science kits which encourage conceptual understanding of chirality, conformations, and isomers by providing a hands-on experience. Students will be able to visually create common functional groups such as ketones, aldehydes, alcohols, thiols, amines, aromatics and most other families of organic compounds.

This kit is highly effective when used in active learning curricula which induces interactive engagement to reinforce conceptually complex ideas. **When students are able to work with their hands in order to construct or design molecules to meet certain specifications, both sensory and motor skills are engaged which increases memory retention** (6)**.** We recommend that our kits be used at least once per week, as research has shown that this is the minimum effective frequency for science kit utilization (14). When used properly, this kit will quantifiably improve student outlook and increase student performance in science.

Visit DuluthLabs.com for ideas on how to incorporate our molecular sets into your curriculum or to order for your courses. Please contact us at contact@duluthlabs.com if you have any questions regarding these kits or the cutting edge educational research which has driven their design.

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