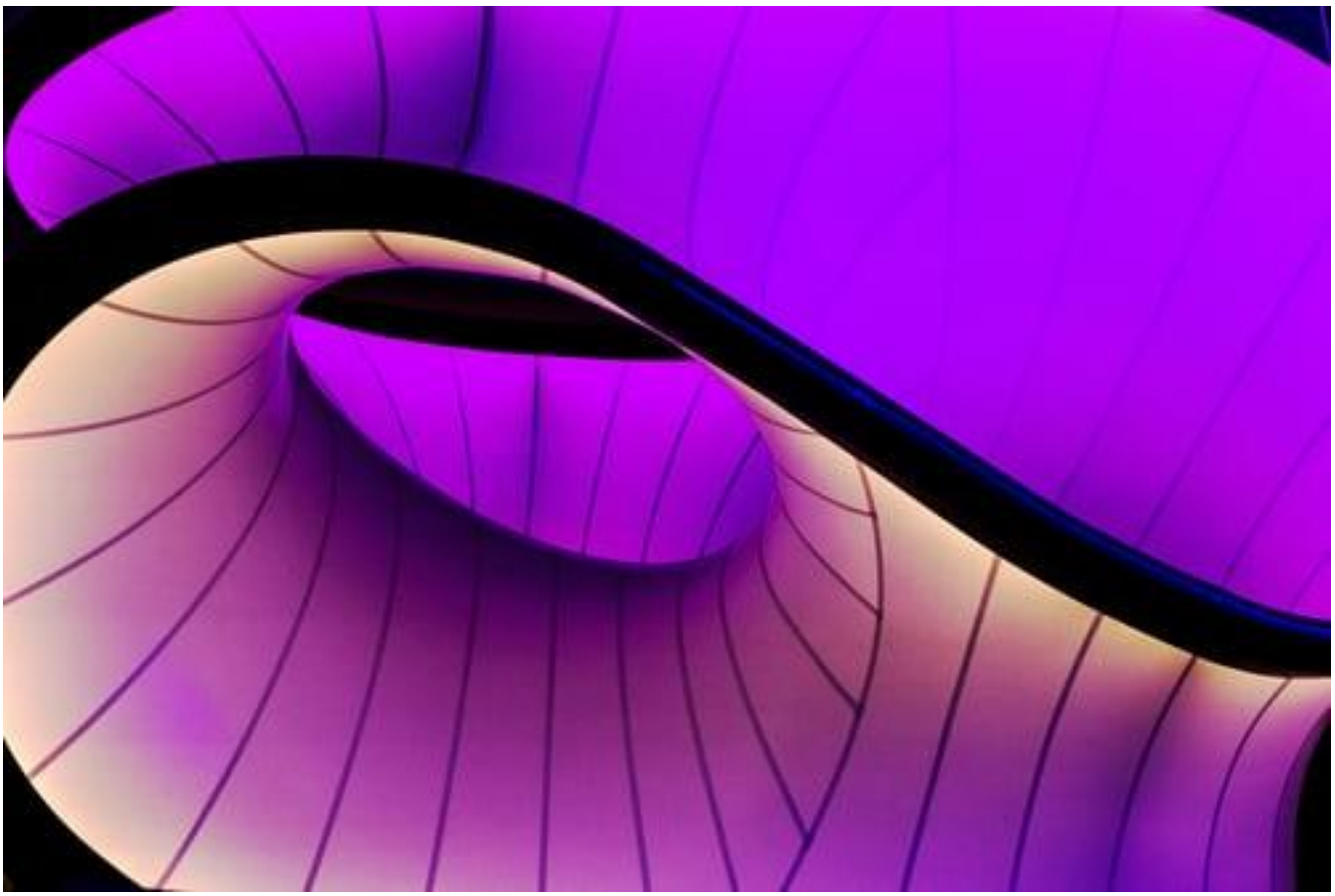
Science and Creativity at King's



Science and creativity may not always be thought of as natural partners. The "arty" subjects are often seen as the home of the creatives. Science is empirical, objective, seeks the "correct" answers, relies on data, not ideas...? Well, yes, good science will always be data-driven but creativity has a role to play, as we heard recently from one of our alumnae.

Dr Julia Wates (FRSC) spoke at our Cafe Scientifique meeting, from her base in Chicago. She explained a vast amount of detailed structural chemistry, all based on data collected by generations of chemists but, importantly, she also explained how her role as an industrial chemist involves "solving real-world problems for customers".

The process begins with a problem posed: cleaning agents are either excellent degreasers, or non-streaky, but not both. The team considers the problem. What chemistry can we bring to solve this? A brainstorming session is held - anything goes, all ideas on the table. This is called "ideation". The chemists draw on their scientific knowledge of molecular properties and suggest candidate molecules. Characteristics are considered until a class of molecules emerges as a potential for further investigation and development. Is this science? Yes! Is it creative - certainly! Those present were inspired to see how a development team really works.

In 2015, PISA (Programme for International Student Assessment, OECD) explored collaborative problem solving, arguing that there was a growing interest in enquiry-based and problem-led learning[1]. The resulting matrix gives a structure to the kind of problem-solving process which we might ask students to undertake:

Matrix of collaborative problem-solving skills

[1] OECD (2017), "PISA 2015 collaborative problem-solving framework", in PISA 2015 Assessment and Analytical Framework: Science, Reading, Mathematic, Financial Literacy and Collaborative Problem Solving, OECD Publishing, Paris, https://doi.org/10.1787/9789264281820-8-en.

	Establishing and maintaining shared understanding	Taking appropriate action to solve the problem	Establishing and maintaining team organisation
Exploring and understanding	Discovering perspectives and abilities of team members	Discovering the type of collaborative interaction to solve the problem, along with goals	Understanding roles to solve the problem
Representing and formulating	Building a shared representation and negotiating the meaning of the problem (common ground)	Identifying and describing tasks to be completed	Describing roles and team organisation (communication protocol/rules of engagement)
Planning and Executing	Communicating with team members about actions to be/being performed	Enacting plans	Following rules of engagement (eg prompting other team members to perform their tasks)
Monitoring and reflecting	Monitoring and repairing the shared understanding	Monitoring results of actions and evaluating success in solving the problem	Monitoring, providing feedback and adapting the team organisation and roles

Source: OECD (2017)

At King's, teaching problem-solving and creativity as part of science is nothing new. Of course, Science teachers have asked students to work together and apply their knowledge to create solutions for generations and it is embedded in what we do. We encourage our students to think through problems, develop formulae, design experiments or explore different ways to reach the same conclusion. Biologists might be asked to use their understanding of indicators to work out how to measure the rate of lipid digestion, Chemists could apply knowledge of molecular structures to understand how cancer drugs interact with DNA and Physicists may use Newtonian mechanics to predict how galaxies interact. Regularly, we set work which draws on knowledge but asks for a creative outcome, like the annual Dr McGale poster competition or Year 7 Natural History Project. This year, Oxford University Physics Department have invited us to enter their "Project Spotlight on Stereotypes", where teams of four Year 9 or 10 students will be mentored by Oxford researchers as they choose a research question, collect and analyse data, and then present their findings in a report and at a schools' conference. We hope their training in problem-solving will stand them in good stead.

Writing in the journal "Curriculum Perspectives", Pam Burnard, Professor of Arts, Creativities and Education at the University of Cambridge recently said *"If we look at the amazing designs that Da Vinci produced, it's clear he was combining different disciplines to advance knowledge and solve problems. We need to encourage children to think in a similar way because tomorrow's adults will have to problem-solve differently due to the existential crises they will face: especially those of climate, sustainability, and the precarity of life on Earth."*[2] Big problems indeed! A case study in a Primary school in Aberdeen saw children develop a vegetable garden while learning about sustainability, food production and design, as well some plant biology, with the finding that *"integration of scientific and artistic perspectives brings forth analytical thinking and empathetic thinking, offering a range of different modalities for 'dwelling' with objects of attention, of thinking*

[2] Burnard, P., Colucci-Gray, L. & Sinha, P. Transdisciplinarity: letting arts and science teach together. *Curric Perspect* **41,** 113–118 (2021). https://doi.org/10.1007/s41297-020-00128-y

and being in the world". Co-incidentally, at King's, a vegetable garden and Bee Keeping Society are both already in the pipeline (thanks to Mrs Renton, the Environmental Action Today Club, the Wildlife and Sustainability Society and Geography Club) – all encouraging our students to think holistically about problems and solutions, using science and design to work collaboratively.

So, even if Science lessons are traditionally more about learning the facts and preparing for examinations which test recall, understanding and application of this in relatively closed questions (which have a right and wrong answer), we are also preparing students to tackle the big, real-life problems. What we want to encourage them to explore is the application of their scientific knowledge to questions without an answer, as yet. At King's, we hope we can combine the development of excellent scientific knowledge with the encouragement of this kind of creative thought as we educate the changemakers of the future.