College Chemistry Canada
La Chimie Collégiale au Canada

Newsletter

VOLUME 43, ISSUE 1 FEBRUARY, 2020

In This Issue

47TH COLLEGE CHEMISTRY CANADA (C3) CONFERENCE, MAY 22-24, 2020

You are cordially invited to attend the 47th College Chemistry Canada Conference, May 22 – 24, 2020, at the Université de Saint-Boniface (USB) in Winnipeg, MB. This year's conference theme is "**Nuts and Bolts Challenges in Chemistry Education, from Primary School to University Level**".

Chemistry concepts begin to be explored as early as in primary school with topics like colours, states and properties of matter, the nature of materials and introduction to particle theory. The concepts become more challenging and sophisticated at the high school and university levels and include investigation of electronic properties of matter, atomic and molecular theories, stoichiometry, and energy transfers. Chemistry education at all levels brings unique learning challenges. The purpose of this year's conference is to bring together the different groups involved in chemistry education (teachers, educators, professors, chemists, and other specialists) so that we may share our experience and knowledge and ultimately better support student success.

Teachers of science or chemistry concepts at primary and secondary levels will find support from the very dynamic C3 community. Teachers of chemistry at the college and university levels will be able to create bonds (no kidding!) with all participants and learn from other educators in the C3 community.

Our enthusiastic (and entertaining) plenary lecturers will be Sharon Brewer (from Thompson River University, Kamploops BC) and Yann Brouillette (from Dawson College, Montréal QC). See the next page for more information!

Visit the conference website for information about the conference program, optional activities, accommodation, and conference sponsorship. Some of the optional activities will include a visit to the Canadian Museum for Human Rights and the Royal Canadian Mint, as well as Beer Tasting, and the Fun Run & Walk.

Registration is available for the full conference only. Early registration rates apply until March 31, 2020.

Presentations are invited from everyone in the teaching community.

Deadline for abstract submission is April 30, 2020.

Please consult the conference website regularly for updates.

Conference Organizers:

François Gauvin (Coordinator, USB Faculty of Science)

Michael Dickman, Bilkiss Issack, Mireille Saint-Vincent, Claude-Rosny Elie (USB Faculty of Science)

Madeleine Asselin and Luc Brémault (USB Faculty of Education)

VOLUME 43, ISSUE 1

COLLEGE CHEMISTRY CANADA 2020 CONFERENCE PLENARY SPEAKERS

Dr. Sharon Brewer
Thompson Rivers University, Kamloops, BC

Sharon Brewer is an Associate Professor of Chemistry at Thompson Rivers University. She is a co-founder with Dr. Bruno Cinel of the BC Integrated Laboratory Network (BC-ILN) which provides remote access to analytical instrumentation for teaching purposes, allowing real-time chemical analysis of real samples over the internet. Her research interests include remote instrumentation as a teaching tool, inquiry based laboratory curriculum, as well as disciplinary research in analytical method development, environmental analysis and water treatment. Dr. Brewer is also the new Registrar of the Association of the Chemical Profession of British Columbia (ACPBC).

Sharon's presentation will be concerned with outreach and linkages between the different levels of institutions and is titled **Connecting through Chemistry.**

Dr. Yann Brouillette
Dawson College, Montréal, QC

Yann Brouillette obtained his Masters in organic chemistry from *Université de Montréal* in 2005 and his Ph. D. in organic chemistry from *Université de Montpellier* in 2008. A chemistry professor at Dawson College in Montreal since 2009, Yann has been a devoted member of the Active Learning Community, an online pedagogical tool developer as well as an educational researcher. In 2014, Y. Brouillette created a new complementary course for non-science students entitled "Comic Book Chemistry" which uses situations portrayed in graphic novels to describe fascinating chemistry. His YouTube channel *ChemCurious* depicts extraordinary features of superheroes reproduced in the laboratory. In addition to writing comic book scripts, he is always looking for new ways to engage students in the learning of science. Overall, Yann Brouillette is not a *mad* scientist, he's a happy chemist!

Yann presentation is titled **Comic Book Chemistry X: Adding Heroes to your Solutions.**

TECHNOLOGY IN THE CLASSROOM: VIDEO LAB SCIENTIFIC REPORTS

Larry Lee (LeeL@Camosun.bc.ca), Camosun College, Victoria, BC

Since joining the Chemistry department at Camosun College in 2006, I have taught ten months during an academic year and so I missed out on opportunities for professional development. Fortunately, in the last two years, my teaching schedule changed and I was able to attend the C3 conference at NAIT in Edmonton, and served as one of the hosts at the most recent conference hosted by Camosun in Victoria. The C3 has a community of very inspiring, knowledgeable, and collegial chemistry instructors mostly from colleges and universities across Canada. At these C3 conferences, I was also impressed and inspired by all the presentations and this motivated me to think of creative ways to improve my teaching pedagogy and to more effectively engage students, which would hopefully result in greater student enjoyment and success in chemistry.

While many of my colleagues interdict the presence of smart devices in the classroom, or in the lab, I fully and willingly support their use in these environments. Students are dependent on their smart devices, but many students are likely not famil-

TECHNOLOGY IN THE CLASSROOM - continued

iar with the productive content on these devices. In order to add value to my students' educational experience, I have recently assigned students to create their own short two to four minute video for their scientific lab reports. (This work is in its initial exploratory stage and I have not developed a set of expectations or a detailed assessment rubric). In a 14-week semester of organic chemistry, I typically schedule eight different laboratory experiments. For two of these experiments, a traditional full laboratory report is required. For the remaining reports, however, I have requested students prepare video presentations.

In my first collection of student lab videos, I came to realize that students require significant guidance, and a clear set of guidelines or expectations for creating their scientific video. In this first batch of student videos, I received random photos with no audio recording to explain the content. Going forward, the guidelines/expectations will include a requirement for:

- a title page with a student's full name and full name of collaborator,
- a title and date of the experiment,
- a short video with narration on the reaction and its mechanism with curved arrows to give the expected products,
- a short video clip of the equipment setup, the addition of reagents, the reaction, the workup, and the analysis of the product,
- an audio reflection on sources of errors, and
- a list of references and acknowledgements.

At first, this might seem like a lot of work, but there are many free smart device applications that will allow anyone to accomplish these tasks smoothly and easily.

I am an Apple iphone user and these free apps include adobe spark video, imovie (works only for IOS 13 or greater), and voice recorder. Another video editing tool is Movavi, which is available as a free version, but I prefer the full version. I also use Word and ChemDraw for my text and chemical structures.

Stay tuned as I am hoping to present this project at the next C3 in Winnipeg!

THINK ABOUT OPENING YOUR TEXTBOOK

Dietmar Kennepohl (dietmark@athabascau.ca), Athabasca University , AB

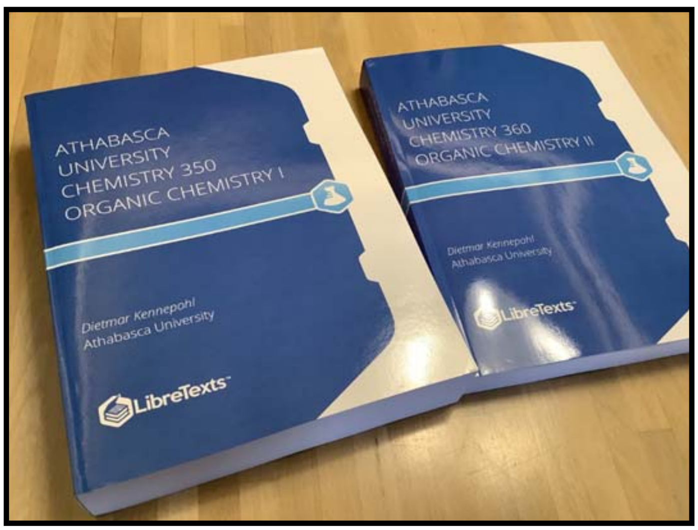
The aspiration of "science for all," with its goal of universal and open access, has really benefited from distance education and new technologies. Of particular interest is the whole movement around open educational resources (OER), which has presented us with a new inclusive way of doing things that should realize savings and reduce barriers to learning (D'Antoni, 2009; Miao, Mishra, & McGreal, 2016). Given the expense of creating or buying resources in the science-related disciplines, coupled with the fact that scientific principles are very transportable, OER seem like a natural option.

It is no surprise among chemical educators that textbooks have become not only more expensive, but disproportionately more expensive when compared with other costs. From 2006 to 2016 textbook prices have increased by 88% in Canada, outstripping inflation (22%), healthcare (39%), and tuition (45%). A Maclean's magazine off-campus university student survey (Brown, 2018) reported an average breakdown of expenses which included rent (40%), tuition (34%), and groceries (8%). While the values might be slightly different for colleges and polytechnical institutions, the textbook component is still only a small fraction (4%) of the overall venture just slightly edging out alcohol (3%). However, from the learners' perspective, costly textbooks can often be experienced as the proverbial straw breaking the camel's back. Indeed, across the country cost of textbooks has been a hot button item for students and institutions have been responding positively to various degrees and with various strategies.

THINK ABOUT OPENING YOUR TEXTBOOK- continued

Three years ago, with a grant from the **C**ampus Alberta Open Educational Resources (ABOER) Initiative (albertaoer.com), we replaced the online commercial textbook for our introductory organic chemistry courses (CHEM 350/360) with access to chemistry LibreTexts (evolved from the ChemWiki project) from University of California at Davis (chem.libretexts.org). The LibreTexts project is a multi-institutional collaborative venture funded by the National Science Foundation to develop the next generation of freely available texts to improve postsecondary education at all levels of higher learning. It consists of 12 pseudo-independently operating and interconnected libraries that host over 70,000 (web) pages of content in chemistry, biology, geology, mathematics, statistics, physics, social sciences, engineering, medicine, agriculture, photosciences, and humanities. It is an open-access environment where both students and faculty write and rewrite content to create a customizable no-fee, high-quality textbook, accessible anytime, anywhere, by anyone through the internet.

The integration of an open textbook in our organic chemistry courses worked well. The LibreTexts environment allows you to add your own material and customize your own textbook. In September 2019, our open textbook was recognized by the Commonwealth of Learning with an Award of Excellence for Distance Education Materials. We are also carefully studying the effects the new textbook has on our students. Early results indicate that while students really appreciate that there is no cost, they still have a lower satisfaction with the open textbook compared with the commercial textbook. Student surveys cite aesthetics in the presentation of materials, broken links, and errors in the material as weaknesses of the open textbook. However, the good news is that student performance (grades) remains unchanged. Still, we continue to fix mistakes and upgrade the formatting of the textbook to better its utility and polish its appearance. Our intention is now to also engage the learner more in writing and rewriting the textbook, so that there is both an appreciation and ownership of the textbook. Students have the option to print of their textbook (PDF files) or, as of October 2019, order a bound print version for just cost of printing ($19). Since the entire course (not just the textbook) is digital and online, we are now looking at the learning analytics to hopefully learn how the textbook is being used within the course.



Many open textbooks are available including the more popular ones like OpenStax (US) and BCcampus (Canada). There are options to use these textbooks in whole or in part, with modifications or as-is. Both the selection and quality of open textbooks is also getting much better, so it is worth investigating for use in your own course. In the right hands, it can be an excellent vehicle for learning and the students will certainly appreciate the price.

Open textbooks are used freely online and PDF files of the pages can be downloaded and/or printed. As of October 2019, students can also order professionally bound print versions ($19) of open online textbooks found at LibreTexts.

References

Brown, M. (2018). The cost of a Canadian university education in six charts. Maclean's Magazine, Education Section, 1 April 2018. Accessed at: https://www.macleans.ca/education/the-cost-of-a-canadian-university-education-in-six-charts/

D'Antoni, S. (2009). Open educational resources: Reviewing initiatives and issues. Open Learning: The Journal of Open, Distance and e-Learning, 24, 3–10.

Miao, F., Mishra, S., & McGreal, R. (2016). Open educational resources: policy, costs, transformation. UNESCO Publishing.

LATEST FROM THE LITERATURE

Sudhir B. Abhyankar (sudhir@grenfell.mun.ca), Memorial University of Newfoundland, Corner Brook, NL.

In an article titled "Students' struggle with multiple representations' in Education in Chemistry, published on February 13, 2020 by Fraser Scott explains how important is it for students to be able to move between chemical representations to grasp fundamental chemical concepts and phenomena? Researchers examined the students' understanding of four basic chemical concepts and considered their competence in moving fluently between the three different levels of chemical representations. A number of helpful tips are provided for you to help your students understand chemical representations.

International Journal of Science Education, 2019, 41(3), describes the research trends in science education based on 1,088 research articles published in Science Education, Journal of Research in Science Teaching, and International Journal of Science Education from 2013 to 2017. The top three research topics, that is, the context of students' learning, science teaching, and students' conceptual learning were still emphasized by researchers in the period of 2013–2017.

Malka Yayon, Shelley Rap, Vered Adler, Inbar Haimovich, HagitLevy, and Ron Blonder describe "Do-It-Yourself: Creating and Implementing a Periodic Table of the Elements Chemical Escape Room", in the J. Chem. Educ. 2020, 97 (1), 132-136. The year 2019 represents the 150th year since the discovery of the periodic table of the elements (PTOE). In honor of this important event, they designed a PTOE chemical escape room (called ChEsRm) that is suitable for middle and high school chemistry students. The main idea behind this ChEsRm is that it is relatively easy and inexpensive for teachers to build in order to introduce the activity into as many chemistry classrooms as possible. The puzzles of ChEsRm include interesting facts regarding the elements, their everyday use, and their properties, as well as the subatomic particles. Some involve actual experiments and other nonlaboratory activities. Participants are asked to solve a mystery: finding the cause of a mysterious death. Although most escape rooms use locks and keys, in this case the mechanism used to reveal the solution is different and more flexible. Here they provide a detailed description of all the puzzles and explain how to operate the escape room in a school lab.

"Detecting and Quantifying Microplastics in Bottled Water using Fluorescence Microscopy: A New Experiment for Instrumental Analysis and Environmental Chemistry Courses" is published by Austin ScircleJames and V. Cizdziel in J. Chem. Educ. 2020, 97 (1), 234-238. Microplastics (MPs) are small plastic particles (<5 mm in size) that are ubiquitous in the environment and have even been detected in bottled water. In this laboratory experiment, suited for instrumental or environmental chemistry classes, students detect and quantify MPs in bottled water by filtering and staining them with Nile red dye prior to utilizing fluorescence microscopy.

Instrumental concepts in fluorescence spectroscopy are reinforced as students build a low-cost fluorescence microscope and use it to collect images of the fluorescing MPs for counting purposes and assessing morphology. The exercise introduces students to MP pollution, an emerging field of chemical research, and motivates and engages them helping to form connections beyond the classroom. Each group detected MPs in their bottled water, and many were surprised by how many they found. Overall, the hands-on experiment received positive feedback from students, and postexperiment assessments showed marked improvement in their understanding of the principles of fluorescence and of the growing problem of MP pollution

In another article by Fraser Scott, October 6, 2019 in" Education in Chemistry" the idea to "Enhance explanations of intermolecular forces" has been detailed. We know from our experience that undergraduate students find it difficult to explain the causes and consequences of intermolecular forces, which are a crucial concept to understand. Recent research indicates that small prompts in questions can help students answer questions about intermolecular forces, specifically London dispersion forces. This article looks at the study and suggests way to implement its findings into secondary school science teaching.

The article published in the International Journal of Physics and Chemistry Education, 2019, 11 (3), by Juan Quílez-Pardo titled "Do the equilibrium constants have units? A discussion on how general chemistry textbooks calculate and report the equilibrium constants" provides an analysis of the literature concerning the dimensionality of equilibrium constants reveals

VOLUME 43, ISSUE 1

LATEST FROM THE LITERATURE - continued

that this topic manifests as a controversial issue. Based on this previous examination, this work studies if general chemistry textbooks accurately define and calculate equilibrium constants. In order to evaluate those textbooks, in the first part of this study the experimental equilibrium constants, K_p and K_c, and the thermodynamic equilibrium constant, K^{o}, are defined. Also, the equations that relate each constant to the other two are given. In the specific presentation of these quantities, an example is discussed both performing their accurate calculation and reporting them using the proper units. In the second part of this study, it is examined the way both first-year university chemistry textbooks and pre-university chemistry textbooks determine equilibrium constants, concentrating on how they handle the units of these quantities. Many textbooks treat K_p and K_c as dimensionless quantities. This misleading assumption is caused by a problem in the terminology used as in many cases K_p (or K_c) plays the role Kº. In order to avoid this misleading treatment of the equilibrium constants some suggestions are provided

Well friends and colleagues, this will be my last submission for the "Latest from Literature column" for the C3 Newsletter. I will retire from Grenfell Campus, Memorial University in Corner Brook after 36 years of doing what we all do best. It has been my privilege to be a part of C3 for the last 35 years. I will cherish this association more than anything else.

Message from the Editor:

On behalf of the C3 community, I would like to extend a sincere thank you to Sudhir for his numerous and much-loved contributions to the C3 newsletter!

"BACK TO THE FUTURE" MY EXCELLENT ADVENTURE IN PROFESSIONAL DEVELOPMENT (PD)

Jimmy Lowe (Jimmy_Lowe@bcit.ca), BCIT, Vancouver, BC

WHY – do a professional development leave? I have always been a proponent of life-long learning. The PD experience can help me acquire some new skills in chemistry and awareness of the current aspects of working in industry. I also think the experience can help me recall the trials and tribulations of being a student. I can share those experiences and knowledge with my students, the Chemistry Dept. and the BCIT Coop program.

HOW – can you get funding? Luckily at BCIT, we have a great PD fund that faculty can apply to. I was successful in my PD application to obtain a 50% leave for the 2019-2020 academic year. Some BCIT faculty had the company cover their salary by taking an approved leave of absence.

WHERE – is my professional development? I used my network to research some companies and found out about Terramera[1]. Located in Vancouver, Terramera has the mission to "unlock the power in nature, so we can live healthier, make clean food affordable and feed the world". Terramera researches plant-based products for pest control and plant protection. I was able to discuss a potential project with a couple of graduate school classmates that were working at the company. After obtaining my PD funding, I was able to confirm my position with the Chemistry Group. You can view some videos about Terramera on their Youtube channel[2].

Terramera

WHAT – has happened so far? I cannot discuss any specifics as I have a non-disclosure agreement. Some days, I am work independently and other times I feel like a new Co-op student[3]. It has been a great learning experience to date – there is lots to learn as there are different areas of experts working together (eg chemical formulations and entomology). In industry, you cannot escape the meetings – there are three scrum meetings a week, and biweekly sprint planning which alternates with the Chemistry group updates. I am getting used to Slack and Asana (team project apps). I implemented a flexible plastic collection program in the Terramera lunchrooms where the plastics are returned as material for Recycle BC's research project[4]. I plan to update my course notes with new concepts learned, molecules for test material and an emphasis for students to develop soft skills. Recently I gave a guest lecture to the BCIT Environmental Health students on botanical pesticides.

"BACK TO THE FUTURE" - continued

That is a quick summary of what I have been up to since my term ended as C3 President. If you are interested in any updates, please correspond by e-mail or catch me at the 2020 conference!

All the best, Jimmy

1. https://www.terramera.com/
2. Terramera Videos on Youtube
3. Note: The last time I officially worked in an industry lab was a summer undergraduate Coop at Ballard (fuel cell technology). https://www.ballard.com/
4. https://recyclebc.ca/flexiblepackaging/

THE QUALITATIVE DETERMINATION OF ACID-BASE STRENGTH: LESSONS FROM THE LITERATURE AND ORGANIC CHEMISTRY TEXTS

Carl Doige (cdoige@okanagan.bc.ca), Okanagan College, Vernon, BC.

The analysis described in this article began many years ago with an observation that many of my second year organic chemistry students struggled with providing coherent arguments and scientific explanations related to a number of key concepts in the course. These concepts included the qualitative determination of acid-base strength, the prediction of the effects of substituents on benzene reactivity, and the discrimination of the impact of different leaving groups on the relative reactivity of carboxylic acid derivatives. Many readers will recognize that the mechanistic arguments and explanations tied to these concepts are based on structural rationales[1]. That is, the specific structural and compositional properties of representative particles can be translated into inferences about specific energy stabilization mechanisms such as induction and electron delocalization[2].

The focus of this article is the qualitative determination of acid-base strength, as acid-base reactions and processes are central to organic chemistry and, next to making predictions about relative strengths of intermolecular forces, this topic is one of the first in the typical organic chemistry curriculum where students are required to construct arguments and explanations about structure-property relationships[3]. Further, as Stoyanovich et al.[4]have documented, a significant number (86%) of common organic chemistry reactions require a BrØnsted-Lowry acid-base step in at least one of the stages of the reaction. Arguably, a full understanding of many of these reactions would also require students to be able to identify the most acidic or most basic atom in the relevant molecules.

Although I am aware there are other ways of considering the relative strength of acid-bases (e.g., bond polarization, bond energies), my approach in teaching this topic has typically been to guide students to consider the relative stability of a negative charged conjugate base (from a neutral acid). Although the electronic factors which are involved in stabilizing an anion (size and electronegativity of the atom bearing the charge, resonance, induction, and the hybridization of the atom bearing the charge) were particularly emphasized in my classes (at least in my mind!), many students were not able accurately predict or justify relative acid-base strength. The students often struggled with balancing the influence of each of the factors, or they would incorrectly associate the size of the halogen (instead of its electronegativity) with the magnitude of the inductive effect, or worse, they would assign a positive charge to the conjugate base of a neutral acid, and reflect on the relative stability of a carbocation. Even if students appeared to accurately interpret the effects of the different factors, they were often unable to articulate their understanding. One particular issue was related to students not being able to explicitly link the stability of the conjugate base to the relative acidity of the acid. For instance, when comparing two acids (HA and HB, for example), the student would correctly identify HA as being more acidic, but support this claim with a statement like, "HA is more acidic because it is more stabilized". Presumably the student intended to write, ".....because its conjugate base is more stabilized". Alternatively, a student would make a case for the better stability of conjugate base A-, and then claim, " … and therefore, it is more acidic". Again the presumption is that the student meant to write, "… and therefore the corresponding acid is more acidic". These last examples may

VOLUME 43, ISSUE 1

THE QUALITATIVE DETERMINATION OF ACID-BASE STRENGTH- continued

seem pedantic, but I argue that attention to such detail promotes greater clarity in thinking and understanding. Most importantly, it is important to ensure that a student is NOT thinking that greater energetic stability signifies that the species is more reactive.

The above observations prompted me to explore the Chemistry Education Research (CER) literature and to examine the presentation of this topic in 10 commonly used organic chemistry textbooks. My hope was to glean a better understanding of the theoretical underpinnings for students' learning challenges related to structure-property relationships, particularly those associated with predicting and explaining acid-base strength. I was also hoping to extract strategies on how to improve students' prediction and reasoning skills. Space constraints permits me to only briefly summarize some of the literature findings here. The interested reader will find a complete literature and textbook analysis, including a proposed learning and assessment template at this link.

It has only been in the last fifteen years that researchers have focused their interests in specifically probing students' models and reasoning of acid-base strength in organic chemistry[5-8.] The reported literature is consistent with and extends my observations. For example, when researchers used ranking tasks for the relative acidity of molecules represented by bond line drawings, followed by prompted explanations, they found that many students will rely on short-cut reasoning procedures (heuristics) which depend on more explicit (and often inappropriate) structural and compositional differences[6]. For instance, a compound may be designated more acidic simply because it has more hydrogen atoms. Other reports, which examined students' mental models of acid-base strength, identified two categories of alternative conceptions[7,8]. These were labeled as *functional group determines acid strength* and *stability determines acid strength*. In the first category, students displayed an over-reliance on looking for the presence of a particular functional group (e.g., COOH) rather than considering the underlying electronic properties such as an atom's electronegativity or the presence of stabilizing factors (induction and/or resonance) for an acid's conjugate base. As an example of the second category, students incorrectly assumed that being able to draw more resonance forms for an anionic conjugate would necessarily result in greater stability. In this reasoning, students are equating "more as better" without considering the relative contributions of each resonance form to the resonance hybrid.

A number of recommendations to improve student learning emerged from these studies including assisting students to be more metacognitive in the appropriate use of heuristics[6] and that "instructors should de-emphasize explicit, structure/composition features of acids and instead focus students' learning on implicit, electronic properties that are critical for meaning-ful learning of chemistry."[8]

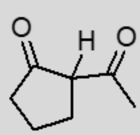
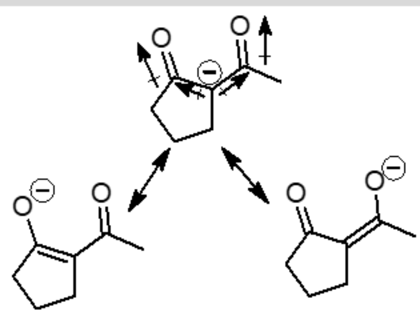
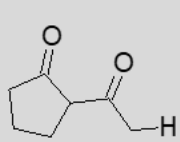
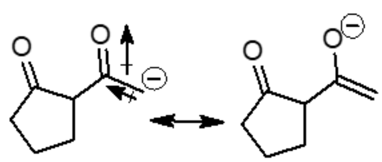
From my perspective, one of the more important outcomes from the studies mentioned above was the observation that students who exclusively used a mental model which was most consistent with the BrØnsted-Lowry model (with a focus on the stability of the conjugate base), although their justifications were not always complete, exhibited a significantly better performance in their ranking tasks[7]. This is in contrast to those students who used models that focused on superficial structure/composition features or even those students whose conception of acid strength was related to an acid as a proton donor whose strength depends on molecular or bond polarity.

Through a consideration of the CER literature (especially the observation described in the above paragraph), the organic chemistry text analysis, and my own observations of student challenges in predicting and justifying acid-base strength, I have developed a learning and assessment scaffolding template. This template essentially operationalizes and extends an approach described in the Klein text[9], where the factors that affect the stability of an anionic conjugate base are considered in a hierarchical order (Atom Effect > Resonance > Induction > Orbital Effect)[10]. The goal of the template is to facilitate the step-wise and systematic analysis of each of the factors using a graphic organizer. The information in the graphic is then translated into a coherent argument/explanation about relative acid strength. Anecdotally, I have now used this scaffolding template for two academic years and have witnessed a marked improvement in the accuracy of the predictions and the quality of the arguments/explanations. A sample template is shown below (Table 1), but again the reader is directed to the following link for a more complete description of the development and use of this template.

References and notes

1. Talanquer, V. (2018a) Importance of Understanding Fundamental Chemical Mechanisms. *J. Chem. Educ.*, 95 (11), 1905-1911.
2. Talanquer V. (2018b) Chemical Rationales: Another Triplet for Chemical Thinking. *Int. J. Sci. Educ.,* 15, 1874-1890.
3. Cooper, M.M.; Stowe, R.L., Crandall, O.M., Klymkowsky, M.W. (2019) Organic Chemistry, Life, the Universe and Every-thing (OCLUE): A Transformed Organic Chemistry Curriculum. *J. Chem. Educ*., 96 (9), 1858-1872.
4. Stoyanovich, C.; Gandhi, A.; Flynn, A.B. (2015). Acid−Base Learning Outcomes for Students in an Introductory Organic Chemistry Course. *J. Chem. Educ*., 92 (2), 220−229.
5. Bhattacharyya, G. (2006). Practitioner Development in Organic Chemistry: How Graduate Students Conceptualize Organic Acids. *Chem. Educ. Res. Pract*., 7 (4), 240−247.
6. McClary, L.; Talanquer, V. (2010). Heuristic Reasoning in Chemistry: Making Decisions about Acid Strength. *Int. J. Sci. Educ.*, 33 (10), 1433−1454.
7. McClary, L.; Talanquer, V. (2011) College Chemistry Students' Mental Models of Acids and Acid Strength. *J. Res. Sci. Teach.*, 48 (4), 396−413.
8. McClary, L.; Bretz, S.L. (2012). Development and Assessment of a Diagnostic Tool to Identify Organic Chemistry Students' Alternative Conceptions Related to Acid Strength. *Int. J. Sci. Educ*., 34 (5), 2317−2341.
9. Klein, D. (2017). Organic Chemistry, 3 ed.; John Wiley & Sons, Inc: Hoboken, NJ.
10. Atom effect = Electronegativity or size of the atom which bears the charge; Orbital effect = hybridization of the atom which bears the charge.

Table 1. Template based on the ARIO[a] factors to guide students to rank and explain the relative acidity for a series of compounds.

ID	Acid[b,d]	CB[b]	A	R	I	O	
1			C^- O^- O^-	✓ ✓	✓ ✓	*sp*^{2}	Both anionic CB's have a similar atom effect (negative charge resides on carbon and oxygen atoms) and the same orbital effect (sp^2 hybridization). Both CB's also have stabilization by resonance and by induction, but these effects are more pronounced in CB1 given a greater number of high contributing resonance forms and the presence of more EWG's[c]. A more stabilized CB1 results in a more acidic CA1.
2			C^- O^-	✓	✓	*sp*^{2}	

[a]ARIO = Atom effect, Resonance, Induction, Orbital effect; [b]CB = conjugate base; [c]EWG = electron withdrawing group. [d]The template is completed from the point of view that the student is asked to rank the relative acidity of the two explicitly drawn hydrogens and justify this ranking.

A CALL FOR NOMINATIONS

Each year College Chemistry Canada presents awards in a number of categories including 1. C3 Award in Chemical Education, 2. C3 Host College Student Scholarship, and 3. the C3 General Student Scholarship. More information about these awards can be found on the C3 website, but it is worth noting that the deadline for nominations for the 2020 awards is fast approaching (March 31 for the Chemical Education award and for the General Student Scholarship). Also note that contributors to the C3 newsletter are eligible for the C3 Editor's Award.

C3 President - Paula Hawrysz

THE PRESIDENT'S MESSAGE

Happy New Year!

I hope this semester is less busy for everyone – last semester went by so fast and this one isn't showing signs of going any slower. In the midst of all the activity, I find myself contemplating the amount of change that occurs when you don't have the time, or take the time, to stop and look about. I'm not much of a philosopher but I often marvel at how quickly a student develops the skills and uses the information that we provide to perform tasks that seemed unsurmountable only six months ago. I guess that's the ultimate reward of being a college chemistry instructor.

Again, I strongly encourage you to recognize your students and colleagues for one of the C3 awards - Educator's Award and Student Award. The deadline for submissions has been extended to the end of March!

We are approaching our 2020 conference at St. Boniface in Winnipeg. Please check the C3 newsletter/webpage for updates and registration information.

Looking forward to a smooth and successful completion of the term. See you soon,

Paula

C3 EXECUTIVE AND BOARD MEMBERS

C3 Executive

President	Paula Hawrysz	NAIT, AB BCIT, BC
Past-President	Jimmy Lowe	BCIT, BC
Treasurer	John Eng	University of Lethbridge, AB
2020 Conference Coordinators	François Gauvin Michael Dickman	Université de Saint-Boniface, MB
Editor	Carl Doige	Okanagan College, BC
Web Master	John Lee	Camosun College, BC
Secretary	Todd Stuckless	Langara College, BC

Regional Directors

Atlantic region	Katherine Darvish	Mount Saint Vincent University, NS
Quebec	Yann Brouillette	Dawson College, QC
Ontario	Andy Dicks	University of Toronto, ON
Prairies	François Gauvin	Université de Saint Boniface, MB
BC/Yukon	Ryan Fradette	Camosun, BC