Report to the IUPAC Science Board 2025
Committee on Chemistry Education

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Part 1. **Highlights of CCE achievements 2023 & 2024**

The past two years were characterised by high productivity on several fronts – project work to advance chemistry education for sustainability, promotion of best practices in chemistry education through conferences and the journal CTI, outreach to support chemistry education in emerging contexts and improvement of internal operations and administration. CCE achievements during 2023 and 2024 are well aligned with the proposed priorities of the Science Board (SB):

- International ranking of the IUPAC journal *Chemistry Teacher International*: The journal was accepted in ESCI, Scopus and DOAJ listings and achieved impact factors 2.2 (Clarivate) and 3.2 (Scopus). The journal is an Open Education Resource that promotes best practices in chemistry education worldwide (SB priorities b & c). Specific mention is made of the recent Special issue on *Teaching Ethics and Core Values in Chemistry Education* (SB priority d).
- A new portfolio for External Relations was established in the CCE to promote and formalise relationships of the CCE with external bodies, such as the OPCW, OECD and UNESCO. The CCE chair is the designated IUPAC observer on the Advisory Board on Education and Outreach (ABEO) of the OPCW for the period 2022 – 2026 and Supawan Tantayanon, the NR for Thailand on the CCE, is a board member of the ABEO. Peter Hotchkiss is an *ex officio* member of the CCE (SB priority a, b, c).
- The flagship event of the CCE, the ICCE conference, was hosted in an exemplary fashion by the Chemical Society of Thailand in Pattaya in July 2024 with the theme, "Power of Chemistry Education for Advancing SDGs". It was attended by 600 delegates from over 50 countries. The program included 6 full- or half-day symposia and 4 workshops focussed on aligning chemistry education with sustainability through small-scale chemistry, systems thinking, green and sustainable chemistry, and safety and security education (SB priorities c & d).
- The CCE completed four projects in 2023 and 2024 and is currently leading five projects that are directly linked to its priorities. CCE is also participating in three projects led by other IUPAC entities. Two new projects that will be led by the CCE are currently under review. During the past three years, the CCE partnered with four divisions (Divs II, III, IV and VI) and four committees (COCI, ICGCSD, CHEMRAWN and CEDEI), but there is scope for wider collaboration (SB priority a - c). Special mention is made of the projects led by Peter Mahaffy and Stephen Matlin to infuse systems thinking in chemistry education and the series of outreach projects to emerging countries on small-scale chemistry led by Supawan Tantayanon. These initiatives advanced chemistry education for sustainability in an impactful manner.
- The CCE developed and documented standard operating procedures for its awards. Apart from the existing lifetime award, Distinguished Contribution to Chemistry Education (DCCE), two new awards were created for Outstanding Early Career Researchers in Chemistry Education and a Special Recognition Award for Excellent Service to the Committee on Chemistry Education (ESCCE).

Part 2. **Plans and priorities for the remainder of 2024-2025 biennium, and beyond** *one-page (~500 words)*

The CCE revised and refined its priorities for the 2022/2023 biennium to ensure deliverability and achieve close alignment with the CCE ToR and the IUPAC Strategic Plan. These priorities remained unchanged for the 2024/2025 biennium. They align well with IUPAC's Mission, Core Values, and the priorities recently proposed by the Science Board (SB):

CCE priorities for 2024-2025	**Alignment**
To develop relationships for working collaboratively with groups both inside and outside of IUPAC	Mission & Core values SB Pr a & b)
To support projects and initiatives that promote and disseminate evidence-based teaching practices and innovations for high-quality chemistry education	SB Pr b & c)
To support both formal and informal chemistry education initiatives that promote public appreciation of the value and contribution of chemistry, as well as an understanding of environmental, ethical, and social responsibility issues related to chemistry	Core values SB Pr b & c)
To support initiatives aimed at integrating the principles of sustainable development in chemistry education	IUPAC Mission SB Pr c)
To support chemistry education in developing countries through outreach programs, targeted projects and regional conferences	SB Pr d)

CCE plans for the remainder of the biennium include the following:

- To further develop the new portfolio for External Relations led by Uday Maitra and Mauro Mocerino. This includes the formalisation of *ex officio* membership for Stephen Matlin to represent the IOCD and Catherine Ngila to represent UNESCO.
- To seek funding from the Project Committee for proposed CCE projects, 2024-020-1-050 (Tantayanon) and 2024-017-1-050 (Soon Ting-Kueh).
- To strengthen ties with the Federation of African Societies of Chemistry (FASC) through liaison with the president, Prof Gloria Ubozur, who also serves as the NR for Nigeria on the CCE.
- To consolidate the operating procedures for CCE awards, and align them with IUPAC timelines for awards.
- To populate the CCE webpage on the IUPAC website with the latest information on CCE activities.
- To work closely with the newly elected CCE chair to ensure a smooth handover in 2026 when the current chair steps down.

Part 3. **Overall report of activities and achievements of Division/Committee since the last report to Council and *organized according to the priorities listed in the Guidelines.***

This section will describe CCE activities during 2023 & 2024 as they relate to the recently formulated priorities of the Science Board.

Priorities (a) and (b) on global scientific collaboration and interaction of relevant external professional bodies to facilitate best practice in chemistry education:

These priorities resonate directly with the first priority of the CCE for this biennium, namely to develop relationships for working collaboratively with groups both inside and outside of IUPAC. In response to the vision of the former IUPAC president for the CCE to take the lead amongst professional science organisations to elevate science education for its relevance to the sustainability imperatives, a new portfolio for External Relations was established in the CCE. The TMs responsible for this portfolio, Uday Maitra and Mauro Mocerino, are currently working to formalise the relationship of the CCE with the IOCD, UNESCO and SHI in 2025 through *ex officio* membership for Stephen Matlin as representative for IOCD, Catherine Ngila to represent UNESCO and Brigitte van Tiggelen as representative for the Science History Institute (SHI). The relationship between the CCE and the OPCW is already formalised through a Memorandum of Understanding whereby Marietjie Potgieter (CCE chair) is the designated IUPAC observer on the Advisory Board on Education and Outreach (ABEO) of the OPCW for the period 2022 – 2026 and Peter Hotchkiss is an *ex officio* member of the CCE. Two meetings of the ABEO were held in 2023 and two in 2024. Prof Supawan Tantayanon, the NR for Thailand on the CCE, is a board member of the ABEO where she makes a valuable contribution.

Priority (c) on outreach and engagement initiatives that contribute to sustainable development

The CCE considers the IUPAC journal, *Chemistry Teacher International* (CTI), and international and regional conferences, to be productive mechanisms for promoting best practices in chemistry education in all contexts, including those in emerging economies. In addition, most of the projects led by the CCE during 2023 and 2024 focussed on the alignment of chemistry education with sustainability imperatives.

Chemistry Teacher International (CTI)

CTI is now in its seventh year of publication and has been accepted in ESCI, Scopus and DOAJ listings. **The latest impact factors are: Clarivate 2.2, and Scopus 3.2**, which places it in the same quartile as the ACS Journal of Chemical Education, a Q2 journal. Mustafa Sözbilir took over from Jan Apotheker in 2024 as the Editor-in-Chief. He expanded the Editorial Board and appointed a 12-member Editorial Advisory Board with balanced gender and geographical representation to promote the journal and strengthen its operation.

Submissions are increasing steadily from a wide range of countries emphasizing the international character of CTI. Four issues are published per year. This included a special issue on *Chemistry and Cultural Heritage* in 2023 and two special issues on *Effective Teaching Tools and Methods to learn about e-Waste* and *Teaching Ethics and Core Values in Chemistry Education* in 2024.

The journal is financially sound, making a small profit every year. The Author processing charge (APC) was increased to € 500 in 2023. Reduction schemes related to the economic development of countries are used.

Conferences

Conferences on chemistry education represent an effective mechanism to advance most of the CCE

priorities for this biennium. The flagship event of the CCE, the 27th International Conference on Chemistry Education (ICCE2024), was hosted in an exemplary fashion by the Chemical Society of Thailand in Pattaya in July 2024 with the theme, “Power of Chemistry Education for Advancing SDGs”. It was attended by 600 delegates from over 50 countries. The program included 6 full- or half-day symposia and 4 workshops focussed on aligning chemistry education with sustainability through microscale chemistry, systems thinking, green and sustainable chemistry, and safety and security in chemistry education (SB priorities c & d). Special mention is made of the LOC chaired by Supawan Tantayanon who spared no effort to maximise the impact and reach of the conference proceedings. She secured sponsorship for 200 school teachers and students (undergrad & grad students) from 50 countries worldwide, and 5 young scientists, to enable them to attend the conference and organised a side event for high school students presided over by the Thai Minister of Education. The 28th ICCE will be hosted jointly with the European Conference of Research in Chemistry Education (ECRICE) in 2026 in Erzurum, Turkey.

The CCE actively supports and contributes to regional chemistry education conferences held biannually in Africa (ACRICE), Asia (NICE) and Europe (ECRICE). IUPAC has endorsed the 9th Network of Inter-Asian Chemistry Educators (9NICE) conference which was held in Kuching, Malaysia from 27 – 30 July 2023 and the 6th ACRICE conference held in Dar es Salaam, Tanzania from 11 – 13 December 2024.

Projects

The CCE completed four projects in 2023 and 2024 (Section IV Part 3, Table 1) and is currently leading five projects that are directly linked to its priorities (Table 2). Two new projects that will be led by the CCE are currently under review (Table 3). CCE is also participating in three projects led by other IUPAC entities (Table 4). During the past three years, the CCE partnered with four divisions (Divs II, III, IV and VI) and four committees (COCI, ICGCSD, CHEMRAWN and CEDEI), but there is scope for wider collaboration.

The project pipeline decreased significantly in 2024 compared to the previous year due to budget constraints; the 2024 project budget (USD 3507) was 18% of the allocation of 2023 (USD 19000). The CCE approved one new project in 2024 as compared to launching four new projects at the start of 2023. The CCE cannot provide adequate funding for new project proposals but will seek additional funds from the Projects Committee.

Special mention is made of the projects led by Peter Mahaffy and Stephen Matlin to infuse systems thinking in chemistry education (#2020-014-3-050, #2023-022-1-050) and the series of outreach projects to emerging countries on small-scale chemistry led by Supawan Tantayanon:

The follow-up project on introducing Systems Thinking to chemistry education (STICE), #2020-014-3-050, and its extension, #2023-022-1-050, have reached important milestones. A website was constructed for the dissemination of information on STICE, Sustainability and Systems Thinking in Chemistry Education (www.sastice.com). The website is an open resource and is populated with carefully designed and tested teaching and assessment materials. Included on the website is the SOCKIT tool for creating dynamic, interactive SOCME diagrams to support teaching and learning. Peter Mahaffy presented a plenary lecture at ICCE2024, and the task group organised symposia and conducted workshops for dissemination during the ICCE 2024 and the BCCE conferences.
The project duration was extended to the end of 2025 to pursue connections made with the chemical industry in 2024. Collective discussions were held with 14 individuals from 10 leading chemical companies which led to the organization of a joint Education and Industry Symposium on "Systems thinking, sustainability and the chemical industry" during the 27th ICCE conference in Pattaya, Thailand. Plans are underway to develop a white paper and case studies which are expected

to promote the deployment of novel and sustainable technology based on systems thinking approaches in the chemical industry.

Supawan Tantayanon, in her capacity as a member and as the president of the Chemical Society of Thailand, has pioneered the introduction of small-scale chemistry to secondary school chemistry teachers in Thailand, Myanmar, Cambodia, Indonesia, Vietnam, Philippines, Nepal, Sri Lanka and India with great success since 2014. The countries reached are all classified as of low or lower middle income according to the World Bank. For all of these target countries, the introduction of small-scale chemistry experimentation offers the possibility that high school students can at least learn from demonstrations done by teachers or have hands-on experiences themselves which would otherwise not be possible for financial and safety reasons. In addition, the project introduces the principles of chemistry for sustainability to 100 teachers from each country through whom it can reach large numbers of students. This project addresses the IUPAC goal to provide scientific expertise to address critical world needs and objectives (SDG4: inclusive and equitable quality education) and the short-term IUPAC objectives to brand IUPAC in the minds of stakeholders and to Support chemistry education in developing countries.

Priority (d) Promotion of diversity and inclusiveness in the profession of chemistry, or of values and ethics in science through responsible practice.

The CCE actively pursues inclusivity in chemistry education by empowering educators in emerging countries through outreach projects and open education resources and securing scholarships for young scientists to attend regional chemistry education conferences. This priority was also served during 2023 and 2024 by the publication of a special CTI issue on *Teaching Ethics and Core Values in Chemistry Education* and a symposium offered during the ICCE2024 conference on Advancing Chemical Safety and Security Education.

CCE Awards

The CCE formalised its biannual awards through careful negotiations and developed and documented standard operating procedures. Apart from the existing lifetime award, Distinguished Contribution to Chemistry Education (DCCE), two new awards were created for Outstanding Early Career Researchers in Chemistry Education and a Special Recognition Award for Excellent Service to the Committee on Chemistry Education (ESCCE). The DCCE award was made to Mei-Hung Chiu (China/Taipei) and two Early Career awards for Shelley Rap (Israel) and Amanda Bongers (Canada). The ESCCE award was not made during this round.

Report to the Science Board 2025: Committee on Chemistry Education
Part 4 Tabular material

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Part 1. Publications resulting from CCE's work for the period covered in the report.

- MacDonald, R. P.; Pattison, A. N.; Cornell, S. E.; Elgersma, A. K.; Greidanus, S. N.; Visser, S. N.; Hoffman M. and Mahaffy, P. G.*, An Interactive Planetary Boundaries Systems Thinking Learning Tool to Integrate Sustainability into the Chemistry Curriculum, J. Chem. Educ. 2022, 99, 10, 3530–3539. https://doi.org/10.1021/acs.jchemed.2c00659
- Reynders, M.; Pilcher, L. A.; Potgieter, M. Teaching and Assessing Systems Thinking in First-Year Chemistry. J. Chem. Educ. 2023, 100 (3), 1357–1365. https://doi.org/10.1021/acs.jchemed.2c00891
- Szozda, A. R.; Mahaffy, P. G.; Flynn, A. B. Identifying Chemistry Students' Baseline Systems Thinking Skills When Constructing System Maps for a Topic on Climate Change. J. Chem. Educ. 2023, 100 (5), 1763–1776. https://doi.org/10.1021/acs.jchemed.2c00955.
- Szozda, A. R.; Lalani, Z.; Behroozi, S.; Mahaffy, P. G.; Flynn, A. B. "Systems Thinking (ST) Encourages a Safe Space to Offer Different Perspectives and Insights": Student Perspectives and Experiences with ST Activities. J. Chem. Educ. 2024, 101 (6), 2290–2307. https://doi.org/10.1021/acs.jchemed.4c00080.
- Delaney, S.; Donnelly, S.; Rochette, E.; Orgill, M. A System Mapping Activity to Visualize Lithium's Interconnectedness to Societal and Environmental Aspects of the Green Energy Transition. Chem. Teacher Internl. 2024, 6 (2), 149–163. https://doi.org/10.1515/cti-2023-0051.
- Mahaffy, P. G.*; Lunn, J.; Adema, A.; Ayotte, A.; Faulkner, J.; Greidanus, S.; Griffioen, A.; Koot, A.; Mimran, Y.; Nanninga, E.; Pfeifer, D.; Struyk, J.; Su, M.; Tesfaye, N.; Wagram, G. Climate Action Can "Flip the Switch": Resourcing Climate Empowerment in Chemistry Education. Chem. Educ. 2024, 101, 9, 3856–3868. https://doi.org/10.1021/acs.jchemed.4c00548

Part 2. Conferences organized and/or endorsed by the CCE

Conference	Location and date	CCE's role
ICCE2024	Pattaya, Thailand 15 – 19 July 2024	IUPAC endorsed the conference. M Potgieter (CCE chair) was the IUPAC representative; she worked closely with the LOC and presented a welcoming address. Mary Garson, IUPAC vice-president, attended the conference.
6th ACRICE	Dar es Salaam 11 - 13 December 2024	IUPAC endorsed, M Potgieter (CCE chair) was a member of the International Advisory Committee.

Part 3. All current Committee projects

Table 1. Projects completed in 2023 and 2024 and their alignment with CCE priorities (Pr) and the IUPAC Strategic Plan (SP)

	Project Numbers and chair	Total Project Budget	Status	Alignment
1	2023-004-2-050; Boniface	USD 1 900	Completed Jan 2024	CCE Pr 4 SP obj 6
2	2022-013-1-050; Potgieter & Kandile	USD 2 500	Completed 20 March 2024	CCE Pr 4&5 SP obj 6&7

3	2023-003-3-050; Zakaria	USD 2 500	Completed 30 June 2024	CCE Pr 3 SP obj 1
4	2023-005-2-050; Tantayanon	USD 5 000	Completed 31 Oct 2024	CCE Pr 4&5 SP obj 6&7

Table 2. Open projects led by CCE and their alignment with CCE priorities (Pr) and the IUPAC Strategic Plan (SP)

	Project Numbers and Chairs	Title	Status	Alignment
1	2023-002-2-050; Delaney & Schultz	International Teacher Survey on Green and Sustainable Chemistry (GSC) Practical Activities	Started 14 Apr 2023, good progress reported	CCE Pr 2&4 SP obj 1&2 SP obj 6
2	2023-029-1-050; Tantayanon	Capacity building of teachers on chemistry teaching with hands-on small-scale experiments in high schools in Asia; India	Started 6 Dec 2023, progress as expected	CCE Pr 4&5 SP obj 6&7
3	2023-026-2-050; Apotheker	The teaching of ethics and core values in chemistry	Started 27 Dec 2023; the special issue of CTI is in print (Dec 2024)	CCE Pr 3 SP obj 6&7
4	2023-022-1-050 (2020-014-3-050 extended) Mahaffy & Matlin	Systems Thinking in Chemistry for Sustainability: Toward 2030 and Beyond (STCS 2030+)	Extended to end of 2025	CCE Pr 2&4 SP obj 1&6
5	2023-031-3-050; Zhilin	Multi-language Dictionary of Terms in Chemistry Education	Started 3 June 2024	CCE Pr 2&5 SP obj 7

Table 3. Projects led by CCE currently under review (Dec 2024) and their alignment with CCE priorities (Pr) and the IUPAC Strategic Plan (SP)

	Project Numbers and Chairs	Title	Status	Alignment
1	2024-020-1-050; Tantayanon	Capacity building of teachers on chemistry teaching with hands-on small-scale experiments in high schools in Asia; Bangladesh	Under review	CCE Pr 4&5 SP obj 6&7
2	2024-017-1-050; Soon Ting-Kueh	Young Ambassadors for Chemistry (YAC) KIMIA Malaysia 2025	Under review	CCE Pr 3&4 SP obj 1&7

Table 4. List of projects with CCE as a partner but no leading role (started in 2023 or 2024).

	Project Numbers; Lead Org.	Title	Start date
1	2023-012-2-022, COCI	Chemistry Entrepreneurship	20 July 2023
2	2024-007-4-300; Div III	Human Wellness and Environmental Sustainability: How Chemistry can make the difference	1 Dec 2024
3	2024-013-2-400; Div IV	Polymer Slide Decks	6 Dec 2024