External Affairs & Communications
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BY ELECTRONIC SUBMISSION

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Re: American Chemical Society: STEM RFI Response

The American Chemical Society (ACS) is a not-for-profit scientific society representing over 150,000 chemists and chemical engineers worldwide. Created in 1876, ACS received a national charter in 1937 from the U.S. Congress which was signed into law by President Franklin Delano Roosevelt.

ACS' mission is to advance the broader chemistry enterprise and its practitioners for the benefit of Earth and its people. As the lead voice for the chemistry enterprise, the ACS is dedicated to bringing members of the chemistry community together to collaborate and advance their science. Chemistry teachers and the K-12 education community are a vital component of ACS membership, and in 2014, ACS proudly launched the American Association of Chemistry Teachers (AACT) to provide networking opportunities, teacher professional development and classroom teacher resources.

ACS welcomes the opportunity to respond to the National Science Foundation's request for input on CoSTEM's 5-year strategic plan and the current and future impacts the COVID-19 pandemic will have on the education system. ACS provided input at the start of the drafting process through stakeholder discussions, and is committed to ensuring the chemistry community is part of this ongoing dialogue. ACS and AACT have collaborated to compile feedback for this submission.

Future Opportunities in STEM Education, questions 1-6 and 8

1. Equitable access to technology for students is an existing challenge exacerbated by COVID-19. ACS recently observed this via ACS Project SEED, its program that offers chemistry research internships to students from economically disadvantaged backgrounds. Due to COVID-19, Project SEED students could not participate in on-site research, so staff organized an extended remote learning experience for students. To offer this experience, however, it was necessary for staff to provide computers and broadband access to many participating

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students. ACS also observes this challenge via its teacher association, AACT. More support is needed to ensure that all students have access to high-speed internet and the equipment necessary to engage in remote instruction.

2. ACS utilizes mentoring and mentoring networks to support teachers and students at all levels. One example is the ACS Science Coaches program, which pairs AACT teacher members with chemistry professionals to provide content knowledge expertise. These networks can be especially helpful during remote instruction, as best practices are still being established through research. These relationships can also help to offset any deficits in administrative support that are crucial to motivating and retaining teachers.

3. Despite the many challenges it presents, ACS has documented some positive experiences with remote learning at the K–12 and higher education level. Virtual or online labs, when used judiciously, allow students to make observations without distractions in a low-pressure setting and repeat procedures as necessary to develop confidence. Another advantage of remote instruction is a greater emphasis on data analysis, scientific writing, and literature review. These benefits may be leveraged to enhance in-person instruction in the future.

4. One challenge specific to the study of chemistry exacerbated by the shift to online learning is the need to provide equitable access to hands-on lab experiences. Due to safety and liability concerns, many students are unable to engage in this important practice during remote instruction and may fall behind in developing lab skills or learning from lab experiences. This has been mitigated to some degree by the use of virtual labs and simulations and leveraging simple experiments using only readily accessible household materials, but these solutions presuppose consistent access to technology and other resources. ACS regards these as temporary solutions and as supplements to hands-on activities but not a substitute for them.

5. ACS has seen significant interest from educators at all levels related to remote instruction. An ACS webinar on "Teaching Remotely Together" attracted over 1,200 attendees and documented the need for follow up sessions exploring teaching methods and resources. ACS also convened over 150 chemistry department chairs to discuss their Fall 2020 challenges and successes in a discussion titled 'Teaching laboratory during the time of COVID-19'. Attendees noted a need for follow-up discussions focused on lessons learned as well as a desire for resources or a repository of strategies for effective virtual laboratory instruction.

AACT drew large numbers of K–12 teachers to a summer symposium on "At Home Activities and Resources for Teaching Chemistry Online." The most popular topics included virtual labs, engaging students equitably in a remote setting, and using technology platforms effectively.

6. To understand the disruption created by COVID-19 at the K–12 level, it would be especially important to research the impact on economically disadvantaged students, those without access to adequate technology, the impact on students' college readiness, and peer interaction.

In higher education, to measure the effects of COVID-19 on STEM education collection of the following information is essential: 1) Data related to the development of hands-on laboratory skills, which may have been affected by the move to virtual laboratory instruction. These hands-on laboratory skills are essential in developing a strong STEM workforce. 2) STEM student attrition rates and graduation outcomes (placements in graduate or professional school, or the workforce) to determine the extent to which the pandemic has impacted the retention and development of a STEM-ready workforce. 3) To assess the impact of COVID-19 on institutional investments in STEM (faculty hiring, research funds, infrastructure upgrades), it is essential to collect data related to institutional funding and the effects of budgetary deficiencies on STEM and STEM-related departments. Collectively, these data would assess the short and long-term impacts of COVID-19 on STEM education in Higher Education. ACS currently collects data on undergraduate outcomes through the ACS Approval Program.

8. ACS moved quickly to support teachers during the transition to remote instruction. A significant portion of the classroom resources on the AACT website were made freely available for an extended period. AACT also provided teachers with a way to grant student access to multimedia on the AACT website, compiled collections of activities that could be done safely using household materials, promoted strategies from teachers, organized webinars on remote instruction, and more.

Develop STEM Education Digital Resources, questions 9-11

9. Through its teacher association, AACT, ACS addresses the importance of classroom resources and professional development to K-12 teachers. Classroom resources developed by teachers that show how to make connections across disciplines and differentiate the approach for learners at different levels would be especially valuable.

At the collegiate level and beyond, ACS has observed the need for curated, peer-reviewed or “approved” resources for laboratory instruction, particularly for upper-division/specialized courses. This resource would be particularly beneficial for resource-strapped institutions.

10. Through its Education Division, ACS supports teachers and learners at all levels of instruction, from K-12 through undergraduate education, to graduate education, and beyond. Through its teacher association, AACT, ACS focuses on K–12 teachers of chemistry, most of whom teach at the high school level. A curriculum that teaches computational literacy through chemistry and other traditional disciplines would ensure that students develop applied digital skills as they acquire the discipline specific knowledge that provides the foundation for them.

As computational literacy becomes increasingly necessary, the need to develop it without displacing traditional disciplines of science becomes an important consideration. A failure to integrate the foundational disciplines of STEM with digital literacy may narrow opportunities for students and slow scientific advances upon which technological advancement relies.

In higher education, the development of a centralized repository of curated or peer-reviewed resources for laboratory/classroom instruction, including examples of learning outcome and program assessment would provide students with an education consistent with the ACS guidelines for undergraduate education in chemistry. These resources would especially benefit resource-limited institutions where faculty may not receive the time needed to develop these materials.

11. ACS has found that teachers value resources categorized by topic (and sub-topic), grade band, resource type, connections to teaching standards or other relevant frameworks, time needed, and materials required.

Increase Diversity, Equity, and Inclusion in STEM, question 12

12. Diversity, Inclusion & Respect are core values of the ACS. Recent events in our country have motivated the Society to reaffirm our commitment to improving diversity through the chemistry enterprise. In 2020, the ACS committed an additional $1 million dollars toward advancing those goals. This funding will help strengthen the ACS Bridge Project, an effort to increase the number of chemical science PhD degrees awarded to underrepresented minority (URM) students, and other successful programs listed below:

The ACS Scholars Program that annually provides approximately $900,000 in renewable scholarships to 350 underrepresented minority students majoring in undergraduate chemistry-related disciplines.

ACS Project SEED, a paid summer internship program for economically disadvantaged high school chemistry students to work in real laboratories, with real scientists serving as their mentors.

The ACS Diversity, Inclusion & Respect webpage has been enhanced to include resources for ACS members and the general public, such as helpful readings, courses and multimedia resources related to this area. The webpage will be the central point for the Society to post its messages and actions related to Diversity, Inclusion & Respect.

Engage Students Where Disciplines Converge, question 13

13. ACS provides a suite of relevant customer-focused resources and professional training opportunities that enable learning and career development across all sectors in the chemical sciences. As stewards of the central science, ACS helps teachers and students make connections to other fields and to learning chemistry through real-world examples and chemistry professionals.

The ACS textbook, Chemistry in the Community, is a first-year high school chemistry textbook that teaches chemistry concepts through the lens of societal issues. The seven units use real-world examples to teach students topics in chemistry such as materials science, environmental chemistry, organic chemistry, biochemistry, and industrial chemistry.

Through its teacher association, AACT, ACS provides a large collection of classroom resources, including lesson plans, labs, demos, and more many of which are aligned with the Next Generation Science Standards (NGSS) and incorporate engineering design where possible. Also through AACT, ACS has partnered with corporate partners such as Dow, Ford, and PPG to develop classroom materials with a real-world focus. The ACS Science Coaches program brings together AACT teacher members with chemistry professionals to help contextualize student learning. The ACS ChemClub program encourages students to make connections to chemistry outside the classroom. These approaches help to meet teacher needs around standards compliance, engage students, and develop future chemists and scientifically literate students.

Develop and Enrich Strategic Partnerships, questions 18 and 19

18. Through the Project SEED program, ACS observes the importance involving students in hands-on research, proving them with mentoring, and connecting them to the broader chemistry community. Due to COVID-19, Project SEED students could not participate in on-site research, so staff organized an extended remote learning experience for students. A clearinghouse of work-based learning programs would be useful in engaging more students in these opportunities.

19. ACS has worked with corporate partners, such as the Dow Chemical Company, to catalyze the formation of local STEM networks. Through these partnerships, ACS has found that investing in teachers amplifies impact, as each teacher works with many students over the course of their career. Another characteristic of success is leveraging local connections to make a national impact. In the case of the Dow partnership, ACS developed “teacher summits” which not only created professional learning communities among the attendees and Dow employees, but did so through resource development, which could be shared with teachers nationally to help meet the need for classroom resources that incorporate real-world connections. Such partnerships also help highlight STEM careers.

Build Computational Literacy, question 20

20. Integrating digital platforms into classrooms offers several benefits, including: more individualized feedback facilitated by effective real-time formative assessment, greater emphasis on individual questions, clarification, and application practice through “flipped learning”, and the ability to use pre-labs or digital supplements to prepare students for a complementary hands-on lab. Challenges arise when there is a disparity in access to technology or when students' digital literacy skills have been cultivated inconsistently. Moving towards a more complete integration of traditional science with computational literacy will require developing curriculum to teach these disciplines through coding, data science, and modeling.

Community Use and Implementation of the Federal STEM Education Strategic Plan, question 24

24. The ACS was encouraged to see a strategic plan that emphasizes STEM literacy, a diverse and inclusive education system and workforce preparedness. ACS, like many professional societies across the country, have looked internally at programs and policies to ensure that we are doing our best to support and encourage a diverse education system and workforce in the STEM fields. A key piece of this puzzle must also be to attract and retain a diverse teacher workforce. As Co-STEM looks to review and strengthen the federal agency commitment to STEM, the support of the STEM teacher workforce is of paramount importance. A core value of ACS is a focus on members, which includes educators at all levels of instruction. ACS sees these teachers, professors, tutors, and informal educators as integral to advancing each strategic pathway.

The ACS appreciates the opportunity to provide feedback on the STEM Strategic plan and to offer input from the stakeholder community on the education landscape in the wake of the COVID-19 pandemic and looks forward to continued collaboration to that end.

ACS would welcome the opportunity to further discuss with NSF the topics touched on in this submittal as well as to provide further information the Foundation might find useful as it finalizes its STEM Strategic Plan.

Sincerely,

Glenn S. Ruskin