Executive Summary
The North Carolina Higher Education Faculty and Mentor Network is a pilot program managed by the North Carolina Association for Biomedical Research (NCABR) in partnership with the Society of Toxicology and the North Carolina Regional Chapter of the Society of Toxicology (NCSOT).

Originally a two-year program, intended to run from June 1, 2020, through June 30, 2022, the Network ultimately received a third and final year of funding in August 2022, allowing it to continue through June 30, 2023. During this third year of funding, the objective was to further expand the Network, reaching more faculty from more colleges and universities in North Carolina in order to disseminate SOT content more broadly about toxicology. The idea was to support more faculty with programming in 2022-23, which was a year more like pre-Covid conditions than any that the Network had experienced since its launch in the heart of the pandemic. This third project year was used successfully to recruit additional faculty to join the Network and to provide in-person programming, for the first time, to support Network members. The in-person meetings held in this final year of the program allowed Network members to forge stronger connections with one another than had been possible through virtual interactions in the prior two years of the project. At June 30, 2023, program activities in this final year resulted in a larger, more tightly knit Network of individuals who are motivated to see the Network’s continuance through partnership with NCSOT in the years ahead.

At the end of the three-year program period, the Network now is comprised of 52 teaching faculty, faculty mentors, and mentors from industry and government, representing 25 organizations in North Carolina. A bevy of resources – recorded programs for undergraduate students, webinars for undergraduate faculty, template resources and lessons learned – now are available for use in North Carolina and in the development of similar networks across the nation in partnership with other SOT regional chapters.
This Report Contains:

I. An Overview of Program Objectives and Goals
II. Three-Year Cumulative Project Outcomes (2020-2023)
III. Program Metrics
IV. Program Feedback
V. Lessons Learned for National Replication
VI. Attachments:

Attachment 1: North Carolina Engagement Data (at year-end 2023, 2022 and 2021)
Attachment 2: Toxicology Curriculum Webinar Series Evaluation Aggregate (September 2021 – April 2022)
Attachment 3: Toxicology Curriculum Webinar Series Evaluation Aggregate (January 26, 2023)
Attachment 4: Network Meeting Evaluation Aggregate (January 6, 2023)
Attachment 5: Network Meeting Evaluation Aggregate (May 19, 2023)

I. An Overview of Program Objectives and Goals:

From its inception, the Network project was not intended to be a membership recruitment effort, although it did result in new memberships for SOT. Rather, its purpose was to advance the Society’s Strategic Plan priority objective (Strategic Objective C1) of increasing SOT’s influence through science communication. The Society had identified two audiences as an initial target for this communication strategy: legislators and educators. The Network pilot program engaged one of these key audiences – undergraduate educators – to increase the recognition and appreciation of toxicology as a science that can have a major, positive influence on human and environmental health.

Ultimately, programs and resources developed and disseminated to undergraduate faculty and students during this three-year program reinforced core messages such as:

- Toxicology is a viable and worthwhile path for students to pursue further education and/or careers. Toxicology intersects with many scientific disciplines.
- Toxicology is a science with real-world implications.
- Toxicologists come from diverse backgrounds and work in many sectors.
- All chemicals (natural, biological, synthetic) can be hazardous if exposure occurs at a high-enough level. Toxicology is about determining risk and toxicologists are the experts in conducting such assessments.
- Science can be controversial and is constantly evolving. Scientists make recommendations based on current understanding and best available information.
Network objectives were to:

- Increase North Carolina undergraduate student involvement in local and national SOT programs;
- Increase North Carolina undergraduate student usage of SOT educational and mentoring resources; and
- Increase the usage of educational materials in North Carolina undergraduate science courses that address the importance and meaning of toxicology.

Program goals were to:

- Establish a network of North Carolina undergraduate faculty and mentors, named the North Carolina Higher Education Faculty and Mentor Network.
- Evaluate existing materials and develop appropriate additional promotional collateral for use with the Network and with North Carolina undergraduate students to begin to address the aforementioned program objectives.
- Support the Network’s undergraduate teaching faculty with resources and instruction to help them integrate core principles of toxicology into their course instruction.
- Use the Network to increase outreach to students, increase student participation in SOT and NCSOT programs, and increase student usage of and access to SOT resources.
- Foster a sense of community amongst Network members in an effort to sustain the Network beyond NCABR’s management of the group.

II. Three-Year Cumulative Program Outcomes (2020-2023):

At the end of the three-year program period, the Network consisted of 52 total people (15 undergraduate educators, 19 mentors and 18 people who considered themselves both educators and mentors). These Network members (four from industry, two from government entities and 19 from academia) represented the following 25 organizations in North Carolina: Appalachian State University, Barton College, Bennett College, Brevard College, Campbell University, Charles River Laboratories, Chowan University, Duke University, East Carolina University, Elizabeth City State University, Fayetteville State University, Gardner-Webb University, High Point University, Inotiv, Livingstone College, National Institute of Environmental Health Sciences, North Carolina Agricultural and Technical State University, North Carolina Central University, North Carolina State University, PETA Science Consortium International, Syngenta Crop Protection, U.S. Environmental Protection Agency, University of North Carolina School of Medicine, University of North Carolina at Pembroke, Western Carolina University.

The goal of the first program year (2020-21) was to establish the Network’s focus and to recruit its inaugural 27 members, who represented 15 different North Carolina institutions. The second program year (2021-22) focused on the development of program content for the existing Network members. That year, only two new Network members joined (no additional organizations were added that year). However, the development that year of the
**Undergraduate Toxicology Discussion Group** on the ToXchange platform to facilitate discussion before and after the seven webinars drew 50 members from 20 states and from 10 countries (all states and countries are listed on the next page). The third year of the program (2022-23) focused on delivering in-person programming and the recruitment of additional **Network** members to benefit from SOT resources and from the **Network**’s recorded programs from the prior two years. These **Network** expansion efforts resulted in 2022-23 in the addition of 23 people from 10 institutions not already reprented in the **Network**.

Products of this initiative included five virtual and two in-person **Network** meetings and 10 virtual Leadership Council meetings, seven webinars in the **Toxicology Curriculum Webinar Series**, which were facilitated by undergraduate educators Joshua Gray and Mindy Reynolds and explored the SOT Toxicology Learning Objectives for undergraduate faculty. The products of this initiative also included four webinars for undergraduate students on a variety of toxicology research and career-related topics. All **Network** meetings (excluding the two in-person meetings in 2023), all **Network** programs and all installments of the the **Toxicology Curriculum Webinar Series** were recorded and are available on the ToXchange platform and online here: [www.toxicology.org/education/edu/ncabr.asp](http://www.toxicology.org/education/edu/ncabr.asp).

Three distinct communities emerged from this initiative:

1. **The Leadership Council:** NCABR developed and recruited a 14-member **Network** Leadership Council, representing SOT, NCSOT, NCABR, Charles River, East Carolina University, Inotiv, North Carolina A&T State University, North Carolina Central University, North Carolina State University, the National Institute of Environmental Health Sciences and the U.S. Environmental Protection Agency. This group met virtually 10 times from June 10, 2020, through November 16, 2022, to guide **Network** messaging, program offerings and promotion, and the **Network** invitee identification and recruitment process.

   - **The Network:** Ultimately, 52 people (not including Dr. Betty Eidemiller, Dr. Ron Hines and the NCABR staff Virginia Crisp, Tonya Hargett, and Suzanne Wilkison) from 25 different North Carolina organizations joined the **Network** by June 30, 2023. These members included 15 undergraduate educators, 19 mentors and 18 people who considered themselves both educators and mentors. To recruit these members, NCABR managed multiple rounds of outreach, contacting 40 people in the first program year (2020-21) and another 467 people from 36 institutions in the third program year (2022-23). Faculty from the following institutions were invited to join: Guilford College, Elon University, Greensboro College, Bennett College, Fayetteville State University, High Point University, North Carolina A&T State University, Johnson C. Smith, Shaw University, Saint Augustine University, Campbell University, University of North Carolina at Greensboro, Davidson College, Barton College, Brevard College, Salem College, Belmont Abbey College, Catawba College, Meredith College, Carolina University, Gardner-Webb University, Montreat College, Chowan University, Queens University of Charlotte, Warren Wilson College, NC Wesleyan University, Lenoir-Rhyne University, Livingstone College, Methodist University, UNC-
Asheville, UNC Pembroke, Western Carolina University, Elizabeth City State University, Appalachian State University, Winston Salem State University, North Carolina Central University.

- **The Undergraduate Toxicology Discussion Group:** This was created in the second year of the program using the ToXchange platform to facilitate discussion before and after the seven webinars. This group had 50 members from 20 states (AZ, CA, CO, CT, DC, FL, KY, IA, MA, MD, ME, MS, NC, OH, PA, TN, TX, UT, VA, WA) and from 10 countries (Brazil, Canada, Ethiopia, India, Netherlands, Nigeria, Saudi Arabia, South Korea, Sweden, USA).

Products, Deliverables and Dissemination from June 1, 2020, through June 30, 2023:

- **Communications Collateral:** NCABR developed two **Network** Fact Sheets, coordinating extensive Leadership Council input, edits and preliminary **Network**-assisted graphic assistance. NCABR developed hard copy and electronic handouts to promote NIEHS summer internships for the undergraduate students taught by **Network** faculty, as well as handouts highlighting the SOT Student Affiliate Program, various SOT undergraduate resources and NCSOT membership benefits.

- **Communications Platform:** NCABR coordinated with SOT Leadership to offer the ToXchange platform for **Network** member communication and resources. Recorded meetings (excluding in-person meetings) and programs are available here: [www.toxicology.org/education/edu/ncabr.asp](http://www.toxicology.org/education/edu/ncabr.asp)

- **Assessments:** NCABR administered the following surveys and evaluations:
  - **Network Teaching Faculty Survey (March 2021):** This survey assessed how best to support **Network** undergraduate teaching faculty in incorporating fundamental toxicological principles into their coursework. Findings from this survey were used to help develop proposed activities for the second year of the program.
  - **Network Mentor Surveys (April 2021 and May 2022):** These surveys collected information about internship opportunities that **Network** mentors have for undergraduate students in North Carolina. The purpose of gathering this information was to share internship opportunities with undergraduate faculty in the **Network** who will help relay this information to students.
  - **Toxicology Curriculum Webinar Evaluation #1 (October 1, 2021):** Posted to the ToXchange with seven respondents.
  - **Toxicology Curriculum Webinar Evaluation #2 (November 30, 2021):** Posted to ToXchange with two respondents.
  - **Toxicology Curriculum Webinar Evaluation #3 (April 11, 2022):** Posted to ToXchange with seven respondents. This evaluation is included as “Attachment 2: Toxicology Curriculum Webinar Series Evaluation Aggregate (September 2021 – April 2022).”
Toxicology Curriculum Webinar Evaluation #4 (January 26, 2023): Posted to ToXchange and sent to Network membership emails with 11 respondents. The evaluation summary is included as “Attachment 3: Toxicology Curriculum Webinar Series Evaluation Aggregate (January 26, 2023).”

Network Meeting Evaluation (January 6, 2023): This evaluation collected feedback about the ideal frequency and format of future Network meetings, topics for future meetings, the overall rating of the January 6 meeting, and general suggestions and comments with 11 respondents. The evaluation summary is included as “Attachment 4: Network Meeting Evaluation Aggregate (January 6, 2023).”

Network Meeting Evaluation (May 19, 2023): The evaluation collected feedback about the ideal frequency and format of future Network meetings, topics for future meetings, the overall rating of the meeting on May 19, and suggestions and comments with 13 respondents. The evaluation summary is included as “Attachment 5: Network Meeting Evaluation Aggregate (May 19, 2023).”

Programs:

Network Launch Webinars (Oct. 1, 2020, and Oct. 15, 2020): Coordinated and hosted two virtual Network launch meetings and disseminated the meeting recording to all members to encourage additional word-of-mouth promotion of the Network to other potential members.

Network 2021 Kick-Off Meeting (January 25, 2021): This program featured presentations by NCABR and SOT Leadership and Network faculty representatives. It highlighted SOT resources and the upcoming national SOT conference and its relevancy for undergraduate students.

NIEHS Webinar about Opportunities for Undergraduate Students (February 3, 2021): This program provided Network members and undergraduate students information about and a virtual tour of the National Institute of Environmental Health Sciences in Research Triangle Park.

Alternatives to Graduate School Webinar (May 18, 2021): This webinar addressed Advising STEM Students on Career Paths in the Toxicological Sciences. The target audience was undergraduate teaching and advising faculty, and it featured panelists from industry, government and academia.

Leadership Council Meeting (June 29, 2021): In this planning session, Leadership Council members discussed a seven-part Network webinar series for undergraduate faculty, including topics, learning framework resources, potential speakers and timing.

Network Meeting about SOT ToxScholar Program, Undergraduate Awards and Upcoming Deadlines (July 19, 2021): This program was for undergraduate teaching faculty and advisors and featured speakers from FUTURE, CDI and NCSOT. Sixteen people attended, another 24 members were emailed afterwards with the recommendation to share the video recording with colleagues and
department chairs with nine agreeing to help disseminate it. The recording was posted on the Network ToXchange.

- **ToXChange Blog Post (August 26, 2021) by NCABR President Suzanne Wilkison:** *Free Instructional Webinar Series for Undergraduate Faculty: How to Incorporate Toxicological Principles into Courses.*
- **Toxicology Curriculum Webinar #1 (September 1, 2021):** Introduced the core concepts of toxicology with Chris Perdan Curran with 21 in attendance.
- **Toxicology Curriculum Webinar #2 (September 29, 2021):** Introduced the core concept of evolution with Jed Goldstone with 15 in attendance.
- **NC SOT Career Panel for Undergraduate Students (October 5, 2021):** NCABR worked with Checo Rorie and NCSOT to host a virtual career panel. NCABR assisted with promotion, use of the NCABR Zoom account and recorded the webinar for NCSOT dissemination.
- **Toxicology Curriculum Webinar #3 (October 18, 2021):** Introduced the core concept of Biological Information: Toxicology and the Genome with Alicia Timme-Laragy with 9 in attendance.
- **Toxicology Curriculum Webinar #4 (November 22, 2021):** Introduced the core concept of Pathways and Transformations of Energy and Matter with Kristine Willet with 17 in attendance.
- **Network Meeting (December 7, 2021):** This meeting provided a preview of the upcoming SOT/NCSOT Annual Meetings and allowed attendees to discuss innovative teaching practices with 13 in attendance.
- **Toxicology Curriculum Webinar #5 (December 14, 2021):** Introduced the core concept of Systems Toxicology with Eva Oberdorster with 14 in attendance.
- **Toxicology Curriculum Webinar #6 (January 28, 2022):** Introduced the core concept of Risk Assessment with Eva Oberdorster with 19 in attendance.
- **“Diversity in Toxicology” Network Program (February 23, 2022):** Targeted at undergraduate students, this program featured Checo Rorie, Tony Baines, Robert Casillas, Kristen Ryan and Schantel Bouknight and drew 34 attendees.
- **ToXchange Blog Post (March 3, 2022) by NCABR President Suzanne Wilkison:** *You Haven’t Missed Out: It’s Not Too Late to Join the Undergraduate Faculty Webinar Series That Makes Teaching Tox Principles Easier*
- **“Using the SOT-NCABR Partnership to Communicate Toxicology to Faculty and Undergraduates” Annual Meeting Presentation (March 28, 2022):** This presentation was delivered in partnership with NCABR by Antonio Baines, a member of the Network Leadership Council. This presentation was part of the “Communicating Science in an Age of Misinformation and Mistrust” session at the Annual Meeting.
- **Toxicology Curriculum Webinar #7 (April 11, 2022):** This webinar looked at the Culmination of Core Concepts to Teach Toxicology with 19 people in attendance.
• **Leadership Council Meeting (September 26, 2022):** This meeting provided a recap of 2020-2022 Network accomplishments, Leadership Council introductions and idea sharing for the third project year, metric goals for 2022-2023, and discussion of the upcoming regional meeting with 13 in attendance.

• **Network Meeting (September 28, 2022):** This meeting provided an update of NCSOT Annual Meeting plans, SOT deadlines and opportunities for undergraduate students and faculty, an update on connecting with SOT ToxScholars and other SOT resources for undergraduate students, and a look ahead at 2022-23 Network activities with 13 in attendance.

• **NCSOT Annual Meeting (October 19, 2022):** NCABR collaborated with NCSOT to provide an exhibit booth at its annual meeting to inform undergraduates and faculty about the SOT Undergraduate Affiliate Program, about the Network and other SOT offerings. This meeting had 217 attendees.

• **Leadership Council Meeting (November 16, 2022):** This meeting provided discussion of plans for the in-person Network meeting scheduled for January 6, 2023, as well as discussion of ideas for next steps for national replication of the Network, discussion of future Network meetings and support, and a recap of the NCSOT annual meeting with seven Leadership Council Members in attendance.

• **Network Meeting (January 6, 2023, In-person):** This meeting was held at Syngenta in Research Triangle Park and provided an SOT/NCABR program overview, lunch and discussion on what Network members would like to glean from the Network, tours of the research facilities and greenhouse, presentations from Syngenta researchers, and discussion on Network next steps with 18 in attendance.

• **Network Meeting (May 19, 2023, In-person):** The meeting was held at the National Institutes of Environmental Health and Sciences (NIEHS) in RTP with an NIEHS program overview, presentation of SOT resources, introduction of Network members, and a roundtable discussion regarding the incorporation of toxicology principles into undergraduate curriculum with 23 in attendance.

• **Dissemination:**
  - At the end of the second program year, NCABR provided a one-pager about upcoming SOT dates and deadlines, the Network Fact Sheets and links to Toxicology Webinar Series recordings and recorded Network programs to the following faculty at HBCUs not already represented in the Network:
    - Dr. Regan Moore, Associate Professor, Biology, Bennett College
    - Ms. Candice Young, Assistant Professor, Biology, Bennett College
    - Dr. Kimberly Raiford, Department Head, Health, Human, and Life Sciences, Shaw University
    - Ms. Tori Williams, Director, Sponsored Programs and Title III, Shaw University
    - Ms. Alfreda Johnson, Grants Coordinator, Shaw University
At the end of the third program year, NCABR provided at the last in-person meeting at NIEHS a one-pager about SOT resources with links to CourseSource, the UC-Davis Mentoring Opportunity for Undergraduates, and SOT Awards application deadlines and information regarding joining NCSOT.

III. Program Metrics

Please see “Attachment 1: North Carolina Engagement Data (at year-end 2023, 2022 and 2021),” which was provided by SOT in spring 2022 and 2023. This data serves as the cumulative progress report for the three-year project period.

Goals:

Higher Education Faculty and Mentor Engagement Goal:
1) Develop the North Carolina Higher Education Faculty and Mentor Network, which will have 20 representatives from industry, government, and North Carolina colleges and universities.
2) Increase the number of North Carolina colleges and universities that use SOT educational materials in undergraduate instruction and/or provide exposure of their undergraduates to toxicology principles and careers to 10.

Undergraduate Student Engagement Goals:
1) Increase North Carolina undergraduate student participation in the SOT Undergraduate Student Affiliate Program to 50 in 2023.

SOT Annual Meeting Engagement:
2) Increase North Carolina undergraduate participation in the SOT Annual Meeting from 34 in 2019 to 60 in 2023.
3) Increase the number of North Carolina colleges and universities with the maximum number of qualified applications for the Undergraduate Diversity Program to 10 in 2023. (There is a maximum of 4 students that can be nominated per school.)
4) Increase the number of North Carolina colleges and universities from which SOT receives applications for the Undergraduate Diversity Program to 10 in 2022.

North Carolina/Regional SOT Engagement:
5) Increase North Carolina undergraduate student participation in the annual NCSOT Regional Chapter meeting in RTP from 36 in 2019 to 60 in 2023.
6) Increase the number of North Carolina colleges and universities with undergraduate students at the NCSOT Regional Chapter meeting in RTP to 8 in 2023.
IV. Program Feedback

A. 2022 Toxicology Curriculum Webinar Series Evaluation
Undergraduate faculty feedback about the seven-part Toxicology Curriculum Webinar series can be found in “Attachment 2: Toxicology Curriculum Webinar Series Evaluation Aggregate (September 2021 – April 2022).” Highlights from this evaluation include:

- Have you incorporated more toxicology into your current courses as a result of viewing the webinars?
  Yes = 71% (5)
  No = 29% (2)

- If you answered no, will you incorporate more toxicology in future courses as a result of viewing the webinars?
  Yes = 100%
  No = 0%

- Has this webinar series impacted whether you will offer an actual toxicology course?
  Yes = 57% (4)
  No = 43% (3)

- Have we increased the transfer of toxicology concept knowledge through this webinar series?
  Yes = 71% (5)
  No = 29% (2)

- Would you be interested in attending more Toxicology Curriculum webinars in the future?
  Yes = 100% (7)
  No = 0% (0)

Additional Toxicology Curriculum Webinar series feedback not in the final, more comprehensive evaluation, included:

*Is the pre-webinar discussion informative? Please explain.*
- “It has been useful to have the pre-webinar discussion as it helps me pause and reflect before the talk. I have learned interesting information as well.”

- “We get a clear idea about the content before the webinar presentation. The case study files and the Pre-discussions about the teaching approaches shared by many staffs are informative.”
If you have not participated in the pre-webinar discussion, why not?

- “Due to the teaching commitments, I don’t get sufficient time to participate in the discussion. However, I follow the discussion and comments shared by members....”

Leadership Council Feedback about the Network:

What evidence can you cite that shows this project was valuable?

- “The widespread audience who tuned in to our virtual sessions from across the country and in other countries.” (Tony Baines)
- “The project resulted in a network of learners and a series of webinars that learners and others attended/watched. Active participation by the target audience is one marker of success.” (Jamie DeWitt)

If this initiative were to continue, what do you wish we could do as a next step?

- “Make sure we move forward in having hybrid events that involve some in-person events. We need to help students gain exposure to toxicology careers found in the government and industry sectors. We need to develop relationships with smaller colleges and universities in regional chapters that do not have graduate programs in toxicology (ex. HBCUs and MSIs).” (Tony Baines)
- “I think it would be fun/interesting to have an annual meeting of Network members, maybe a ½ day conference of presentations and breakout meetings to discuss implementation successes and challenges.” (Jamie DeWitt)

Do you have general thoughts and reflections on this project that you wish to share with SOT Leadership?

- “I think this opportunity can be used to really help spread the word about toxicology to students across the country, especially from diverse communities.” (Tony Baines)
- “Overall, this project/initiative was a great idea to broaden the appreciation of toxicology and the benefits of toxicology education at the undergraduate level. I wish that I had learned about toxicology earlier in my educational process...it might not have taken me so long to find my disciplinary home! It would be great to see this project expand beyond NC.” (Jamie DeWitt)

Feedback from Toxicology Curriculum Webinar Facilitators:

- “As a whole, I think this webinar provides instructors with a way to align their courses with vision and change and the core principles of toxicology. It also provides examples for each. Many people when they are teaching toxicology courses struggle thinking about which topics and concepts are the most important and this gives a great foundation.” (Mindy Reynolds)
• “I think having live webinars is nice as a way to build community when we can. I did like how these webinars had more back and forth discussions than usual. It made prepping them somewhat easier, but also I think was more interesting to me and the attendees. I would add these to the growing list of faculty development items we have at the SOT website. The alignment with Vision and change and our framework makes for a really nice synergy.” (Joshua Gray)

**B. 2023 Toxicology Curriculum Webinar Series Evaluation**

Undergraduate faculty were asked to review the webinar series content nine months after the series concluded in an effort to give faculty time over their summer (2022) and their fall semester (2022) to review content and possibly incorporate it into their teaching. This feedback can be found in “Attachment 3: Toxicology Curriculum Webinar Series Evaluation Aggregate (January 26, 2023).” Highlights from the evaluation include:

• Of the webinars that you attended or watched, which one(s) did you find most useful for curriculum development or which one(s) may be most useful in the future for curriculum development?
  - An Introduction to the Core Concepts of Toxicology = 45% (5)
  - Pathways & Transformations = 36% (4)
  - Risk Assessment = 36% (4)

• As you think to your future teaching, which toxicological concepts addressed in the webinars will be the easiest to incorporate into your courses?
  - An Introduction to the Core Concepts of Toxicology = 45% (5)
  - Risk Assessment = 27% (3)

• As you think to your future teaching, which toxicological concepts addressed in the webinars will be the most challenging to incorporate into your courses?
  - A Focus on Evolution = 18% (2)
  - Systems Toxicology = 18% (2)

• Which toxicological concepts addressed in the webinars did the most to expand and/or enhance what you are already teaching?
  - Pathways and Transformations of Toxicants, from Dose-Response to ADME = 18% (2)
  - Risk Assessment = 18% (2)

Additional Toxicology Webinar Series feedback included:

“Coming into Toxicology from human genetics/biochemistry and no formal tox courses, the webinars have been very useful to not only increase my own tox knowledge but have enabled me to integrate tox concepts into multiple courses and offer a special topics in toxicology & biochemistry course.”

“They [the webinars] provided ways for me to present or make connections for my students on
those topical areas.”

“This was a great series that got the community together regularly, hopefully generating a community of practice in toxicology education that continues into the future. What is next?”

V. Lessons Learned for National Replication

Step 1: Partnerships & Leadership Council

With an SOT Regional Chapter serving as the hub of activity for a prospective network of teaching faculty, faculty mentors, and mentors from industry and government in a given geographic area, immediate first steps would be to:

- **Identify partnering organizations** to coordinate launch activities, facilitate network meetings and programs and to hold partners accountable for activities and desired endpoints. In terms of timing, partners should be secured about nine months before network activities are desired. NCABR found securing partners and identifying Leadership Council members in January through May to be desirable so planning could take place in June through August before the start of the fall semester. Possible planning partners may be retirees in your community who are or have been involved with SOT and who may have more time to assist in this sort of work.

- **Identify Leadership Council members** from the local SOT regional chapter to determine the network goals and activities and to use professional contacts to invite other members to join the network. Leadership Council Members also will serve as meeting facilitators and webinar presenters. We found securing these contacts in April and May to be ideal timing to begin virtual planning meetings in June-August so all plans were in place before the fall semester.

- **Consult SOT, NCABR and NCSOT for help with questions and guidance.**

Step 2: Collateral Development

A critical step in the planning and launch of a new network is to keep all partners and Leadership Council Members on the same page with how to focus time and energy. SOT and regional SOT chapter members are passionate! They bring tremendous professional expertise, energy and commitment to supporting SOT operations. Setting goals and expectations took place for the North Carolina Network through the development of two Network Fact Sheets in the first months of the project. These Fact Sheets could be used by other regional groups as a jumping-off point when determining what their network will aim to accomplish. The North Carolina Network spent upwards of two months refining these Fact Sheets to make sure that all were in agreement about direction, focus and how to devote time and resources.

Aside from having your network’s goals determined and clearly stated, it is important to identify ways for sharing meeting information and announcements once a network launches.
The North Carolina Network used the ToXchange platform for communication and for hosting links to all recorded meetings and webinars. Even the process of setting up communication channels can take more time than might be expected. It is recommended to budget a month or two for this planning aspect.

**Step 3: Program Offerings – Pick Your Focus**

North Carolina Network meetings and webinars from 2020-2023 are hosted on the ToXchange platform and online at [www.toxicology.org/education/edu/ncabr.asp](http://www.toxicology.org/education/edu/ncabr.asp) and can be used with undergraduate faculty and students in other states. Reviewing these materials would be a good first step before determining which offerings to provide constituents in other similar networks in case something available in the library of the North Carolina Network may be used elsewhere – or also as a foundation for idea generation with other networks.

Planning and executing network meetings and webinars is a time-consuming process that requires one or two volunteers or paid staff to manage. As was discovered in the third program year of the North Carolina Network, in-person meetings are the best way to forge relationships and to foster motivation for a group to thrive and continue. Virtual meetings are practical, easier to execute and keep a group united between in-person meetings, but nothing takes the place of the connections forged at meetings held in person. As such, it is recommended that in-person meetings be a periodic aspect of any future network efforts.

**Reminder: Rome was not built in a day.**

A key take-away from the North Carolina Network pilot project was the realization that Network formation, the production of programs and the impact of those programs on the desired audience – undergraduate students – is a process that requires patience and some flexibility amongst partners. Faculty members are busy. Faculty members are well intentioned and reported to us that they needed the summer to review Network content before their fall semesters, but we could not expect to see curriculum shifts and changes in the midst of an ongoing semester. For example, curriculum webinars were provided throughout the 2021-22 academic year but it would be anticipated that content from webinars would be used in subsequent semesters and not necessarily immediately. This is why additional, longer-term follow-up evaluation of North Carolina Network members was needed, and this longer-term feedback can be used to guide similar networks throughout the nation. A longer-term evaluation was conducted in January 2023 with the assistance of Dr. Jamie DeWitt, a Network Leadership Council Member, to look at the effectiveness and impact of the Toxicology Curriculum Webinar series. The evaluation summary can be found in “Attachment 3: Toxicology Curriculum Webinar Series Evaluation Aggregate (January 26, 2023).”
North Carolina Engagement Data from SOT June 2023, 2022 and 2021

Higher Education Faculty and Mentor Engagement Goal

1) Develop the North Carolina Higher Education Faculty and Mentor Network, which will have 20 representatives from industry, government, and North Carolina colleges and universities.
   - **Outcome at June 30, 2023:** There are 52 members of the North Carolina Higher Education Faculty and Mentor Network (15 undergraduate educators, 19 mentors and 18 people who considered themselves both educators and mentors).
   - **Outcome at June 30, 2022:** There are 29 members of the North Carolina Higher Education Faculty and Mentor Network (5 undergraduate educators, 13 mentors and 11 people who considered themselves both educators and mentors).
   - **Outcome at June 30, 2021:** There are 27 members of the North Carolina Higher Education Faculty and Mentor Network (5 undergraduate educators, 12 mentors and 10 people who considered themselves both educators and mentors).

2) Increase the number of North Carolina colleges and universities that use SOT educational materials in undergraduate instruction and/or provide exposure of their undergraduates to toxicology principles and careers to 10.
   - **Outcome at June 30, 2023:** 5 ToxScholar visits to North Carolina institutions in the 2022-23 project period.
     - Bennett College (Bob Roth)
     - North Carolina Agricultural and Technical State University (Bob Roth)
     - North Carolina Central University, October 5, 2022 (Michael Peterson, Gradient)
     - UNC Pembroke, September 23, 2022, virtual panel discussion (Brandiese Beverly, Ph.D., NIEHS; Schantel Bouknight, Ph.D., Charles River; Jeffery Ambrose, Ph.D., RTI International)
     - UNC Pembroke, October 6, 2022 (Mike Peterson, Gradient)
   - **Outcome at June 30, 2022:** 0 ToxScholar visits to North Carolina institutions, likely due to COVID impacts.
   - **Outcome at June 30, 2021:** 0 ToxScholar visits to North Carolina institutions, likely due to COVID impacts.

Please see “Attachment 2: Toxicology Curriculum Webinar Series Evaluation Aggregate (September 2021 – April 2022)” and “Attachment 3: Toxicology Curriculum Webinar Series Evaluation Aggregate (January 26, 2023)” for comments from undergraduate faculty about the webinar content that already has been and/or will be incorporated into course instruction.
Undergraduate Student Engagement Goals
1) Increase North Carolina undergraduate student participation in the SOT Undergraduate Student Affiliate Program to 100 in 2023.
   - **Outcome at June 30, 2023:** 17 students from the following nine North Carolina institutions participated in the SOT Undergraduate Affiliate Program in 2022-23: Davidson College, Duke University, Elizabeth City State University, Fayetteville State University, High Point University, North Carolina A&T State University, North Carolina Central University, University of North Carolina at Greensboro, University of North Carolina at Pembroke.
   - **Outcome at June 30, 2022:** 13 students from seven North Carolina institutions participated in 2021-22: Duke University, Elizabeth City State University, Meredith College, North Carolina A&T State University, North Carolina Central University, North Carolina State University and University of North Carolina at Chapel Hill.
   - **Outcome at June 30, 2021:** Five students from five North Carolina institutions participated in 2020-21: UNC-Chapel Hill, Meredith College, North Carolina Central University, High Point University and North Carolina Central University.

2) Increase North Carolina undergraduate participation in the SOT Annual Meeting from 34 in 2019 to 60 in 2022.
   - **Outcome at June 30, 2023:** 10 students from eight institutions registered for the 2023 meeting.*

<table>
<thead>
<tr>
<th>Institution</th>
<th>2023 UDP</th>
<th>2023 SURA</th>
<th>2023 Other</th>
<th>2023 Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duke University</td>
<td>1</td>
<td>1</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Elizabeth City State University</td>
<td></td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Fayetteville State University</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Livingstone College</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>North Carolina A&amp;T State University</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>North Carolina Central University</td>
<td></td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>North Carolina State University</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>University of North Carolina-Chapel Hill</td>
<td>1</td>
<td>1</td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>

* The data includes students from institutions such as Duke University, Elizabeth City State University, and others, who participated in the SOT Undergraduate Student Affiliate Program.
Attachment 1: North Carolina Engagement Data (at year-end 2023, 2022 and 2021)

- **Outcome at June 30 for years 2020, 2021 and 2022:**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Duke University</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elizabeth City State University</td>
<td>3</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meredith College</td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>National Institute of Environmental Health Sciences</td>
<td></td>
<td>0</td>
<td></td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Carolina A &amp; T University</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Carolina Central University</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Carolina State University</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of North Carolina at Chapel Hill</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of North Carolina Greensboro</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>4</td>
<td>3</td>
<td>10</td>
<td>17</td>
<td>4</td>
<td>0</td>
<td>9</td>
<td>13</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>8</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td># Institutions</td>
<td>7</td>
<td>7</td>
<td></td>
<td></td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Notes:
- The 2020 Annual Meeting was cancelled due to the pandemic but its registration numbers reflect an audience that anticipated an in-person conference.
- The 2021 Annual Meeting was virtual.
- The 2022 Annual Meeting was hybrid with pandemic concerns on-going throughout (and potentially affecting) registration.
- The 2023 Annual Meeting was in person.

**North Carolina/Regional SOT Engagement**

3) Increase the number of North Carolina colleges and universities with the maximum number of qualified applications for the Undergraduate Diversity Program to 10 in 2022. (There is a maximum of 4 students that can be nominated per school. **Note: this restriction was dropped in 2022.**)

4) Increase the number of North Carolina colleges and universities from which SOT receives applications for the Undergraduate Diversity Program to 10 in 2022.

**A. Students from North Carolina: UDP and SURA Awards**

- **Outcome at June 30, 2023:**

<table>
<thead>
<tr>
<th>Institution</th>
<th>UDP Applied</th>
<th>UDP Accepted</th>
<th>SURA Applied</th>
<th>SURA Accepted</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Carolina Central University</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Duke University</td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>North Carolina State University</td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Fayetteville State University</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of North Carolina at Chapel Hill</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Livingstone College</td>
<td>1</td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

*student declined award
Attachment 1: North Carolina Engagement Data (at year-end 2023, 2022 and 2021)

- **Outcome at June 30 for years 2020, 2021 and 2022**

<table>
<thead>
<tr>
<th>Award applications</th>
<th>2022</th>
<th>2021</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Applied</td>
<td>Awarded</td>
<td>Applied</td>
</tr>
<tr>
<td># UDP Applications</td>
<td>5</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td># Institutions</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td># SURA Applications</td>
<td>4</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td># Institutions</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

B. North Carolina Institutions (UDP and SURA applications)

- **Outcome at June 30, 2023**:

<table>
<thead>
<tr>
<th>Applications</th>
<th>Accepted</th>
</tr>
</thead>
<tbody>
<tr>
<td># UDP Applications</td>
<td>4</td>
</tr>
<tr>
<td># UDP Institutions</td>
<td>3</td>
</tr>
<tr>
<td># SURA Applications</td>
<td>3</td>
</tr>
<tr>
<td># SURA Institutions</td>
<td>3</td>
</tr>
</tbody>
</table>

- **Outcome at June 30 for years 2020, 2021 and 2022**

<table>
<thead>
<tr>
<th>Institution</th>
<th>2022</th>
<th>2021</th>
<th>2020</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td># apps</td>
<td>accepted</td>
<td># apps</td>
<td>accepted</td>
</tr>
<tr>
<td>North Carolina Central University</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>North Carolina A&amp;T State University</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Fayetteville State University</td>
<td>2</td>
<td>1/1 D</td>
<td>2</td>
<td>1/1 D</td>
</tr>
<tr>
<td>North Carolina State University</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of NC Chapel Hill</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

D=# accepted who declined
*Student received Pfizer rather than UDP

Notes:
- Only NC A&T has nominated 4 UDP applicants in one year, 2019
- **2022**: Restriction of four applications per institution for UDP was removed; no institution nominated four.
- UDP=Undergraduate Diversity Program, managed by the Committee on Diversity Initiatives
- SURA=SOT Undergraduate Research Award, managed by FUTURE Committee
North Carolina/Regional SOT Engagement

5) Increase North Carolina undergraduate student participation in the annual NCSOT Regional Chapter meeting in RTP from 36 in 2019 to 60 in 2022.

6) Increase the number of North Carolina colleges and universities with undergraduate students at the NCSOT Regional Chapter meeting in RTP to 10 in 2022.

Outcome at June 30, 2023:

A. 73 undergraduates from nine colleges and universities registered for the annual NCSOT Regional Chapter meeting in Durham, N.C., at North Carolina Central University on October 19, 2022.

<table>
<thead>
<tr>
<th>Institution</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Duke University</td>
<td></td>
</tr>
<tr>
<td>2 Fayetteville State University</td>
<td></td>
</tr>
<tr>
<td>2 Meredith College</td>
<td></td>
</tr>
<tr>
<td>22 North Carolina A&amp;T State University</td>
<td></td>
</tr>
<tr>
<td>35 North Carolina Central University</td>
<td></td>
</tr>
<tr>
<td>1 North Carolina State University</td>
<td></td>
</tr>
<tr>
<td>1 University of North Carolina</td>
<td></td>
</tr>
<tr>
<td>1 University of North Carolina at Greensboro</td>
<td></td>
</tr>
<tr>
<td>6 University of North Carolina at Pembroke</td>
<td></td>
</tr>
</tbody>
</table>

Outcome at June 30, 2022:

<table>
<thead>
<tr>
<th>Institutions</th>
<th>2022 Students</th>
<th>2021 No ug activity</th>
<th>2020 Faculty</th>
<th>2019 Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duke University</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Carolina A &amp; T University</td>
<td>2</td>
<td>5</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>North Carolina Central University</td>
<td>2</td>
<td>1</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>University of NC at Chapel Hill</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>The University of North Carolina at Greensboro</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Totals</td>
<td>6</td>
<td>6</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td># Institutions</td>
<td>4</td>
<td></td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>
B. 4 Regional Chapter Nonmember Faculty participated in the annual NCSOT Regional Chapter Meeting in Durham, N.C., at North Carolina Central University on October 19, 2022.

<table>
<thead>
<tr>
<th>4 RC Nonmember faculty</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>University of North Carolina at Pembroke</td>
</tr>
<tr>
<td>2</td>
<td>St. Augustine's University</td>
</tr>
<tr>
<td>1</td>
<td>North Carolina A&amp;T</td>
</tr>
</tbody>
</table>

C. 4 Post-baccalaureates participated in the annual NC SOT Regional Chapter Meeting in Durham, NC at North Carolina Central University

| 4 | Postbacs (EPA-ORISE, NTP-NIEHS) |
1. Did you attend any of the Toxicology Curriculum webinars and/or watch any of the webinar recordings?
   o Yes = 100%
   o No = 0%

2. Which webinars did you attend live (not in recorded format)?
   o Webinar #1 on September 1, 2021 (Introduction of Core Concepts) = 21% (4)
   o Webinar #2 on September 29, 2021 (Evolution) = 5% (1)
   o Webinar #3 on October 18, 2021 (Biological Information) = 16% (3)
   o Webinar #4 on November 22, 2021 (Pathways & Transformations) = 16% (3)
   o Webinar #5 on December 14, 2021 (Systems Toxicology) = 16% (3)
   o Webinar #6 on January 28, 2022 (Risk Assessment) = 10% (2)
   o Webinar #7 on April 11, 2022 (Culmination of Core Concepts) = 16% (3)

3. Which webinars did you watch as a recording?
   o Webinar #1 (Introduction of Core Concepts) = 8% (1)
   o Webinar #2 (Evolution) = 15% (2)
   o Webinar #3 (Biological Information) = 0
   o Webinar #4 (Pathways & Transformations) = 15% (2)
   o Webinar #5 (Systems Toxicology) = 15% (2)
   o Webinar #6 (Risk Assessment) = 15% (2)
   o Webinar #7 (Culmination of Core Concepts) = 8% (1)
   o None = 24% (3)

4. Which webinar did you find to be the most useful and why?
Each have their own importance. I loved risk assessment.

- Systems toxicology
- I will watch these over summer break, so am unable to answer this question right now. During the semester is just so busy that I haven't gotten a chance to look at all of them yet.
- I enjoyed the Systems Toxicology webinar the best. They were all very good and prompted me to think further about how to best integrate toxicology into my courses. I especially enjoyed learning about the experiences/resources of others.
- I found the one on biological concepts most useful. If I am remembering correctly, this one is where people suggested different readings, websites and case studies for use in teaching these concepts.
- All of them, but especially the first one and the forums.
- All that I attended - sorry I was in my busiest year in my 20 at [name of institution redacted] or I would have been able to join more! I found the different perspectives on teaching useful, although there are obviously many different learning outcome goals for the respective courses that the presenters provided materials for.

5. How did this series impact your teaching?
   - This is very good series. Keep me posted if any future webinars would be organized.
   - I learned the student centric teaching methods followed by UG educators in USA.
   - So far, it has not yet impacted my teaching. But I plan on using these over the summer to get better ideas.
   - I created an assignment in one of my courses to integrate toxicology.
   - Gave me some great ideas as to how to organize certain concepts as well as resources for where to find good information for building lectures and assignments.
   - It helped me develop my syllabus in a different way and find excellent resources and ideas (I was developing an Intro to Tox class for spring quarter).
   - I will definitely attempt to build some of the materials into the course I teach. But it is already packed due to the community-based research projects built into my course as it is. I'll replace some of the outdated lectures with newer materials.

6. Have you incorporated more toxicology into your current courses as a result of viewing the webinars?
   - Yes = 71% (5)
   - No =29% (2)

7. Which core concepts have you incorporated in your courses so far?
   - Biological Information = 15% (2)
   - Pathways & Transformations = 31% (4)
Attachment 2: Toxicology Curriculum Webinar Series Evaluation Aggregate (September 2021 – April 2022)

- Risk Assessment = 15% (2)
- Systems Toxicology = 31% (4)
- Evolution = 8% (1)

8. If you answered no, will you incorporate more toxicology in future courses as a result of viewing the webinars?
   - Yes = 100%
   - No = 0%

9. Which three ideas do you plan to incorporate in your courses?
   - Risk assessment of medical devices
   - AOPs
   - Toxicity testing
   - Student centered learning assignments.
   - Case history discussion on poisoning / ADR and the feedback from students
   - Real world problems and the toxicological science behind it
   - After explaining a normal physiological mechanism, I will use a real world tox example to reinforce the concept
   - I plan to integrate risk assessment in my general chemistry course.
   - I plan to include an assignment to look at the toxicology aspect of drugs/medications in one course.
   - I plan to integrate risk assessment into a chemical literature course.
   - Adding additional case studies
   - Adding some more up to date readings and re-organization of lectures
   - More of the core concepts from vision and change and some green chemistry.
   - My course is already focused on Ecotox, so adding more materials is not goal - I'm looking for better materials for UG/MS level learners.
   - I'll add some of the lecture materials shared with the group.

10. Has this webinar series impacted whether you will offer an actual toxicology course?
    - Yes = 57% (4)
    - No = 43% (3)

11. Has the webinar series increased the frequency that you will offer a toxicology course?
    - Yes = 29% (2)
    - No = 71% (5)

12. Have we increased the transfer of toxicology concept knowledge through this webinar series?
    - Yes = 71% (5)
    - No = 29% (2)

13. If yes, how?
Attachment 2: Toxicology Curriculum Webinar Series Evaluation Aggregate (September 2021 – April 2022)

- You can do four webinars in each month.
- The use of case history for teaching was new to me and I have incorporated them in teaching UG and PG toxicology courses.
- By creating assignments/learning modules with a toxicology twist.
- Having allowed multiple faculty from many universities to sort of "get on the same page" with what we want to teach and how we can best present the information to our students, we are now equipped to all share this information with the next generation. Hopefully some of these students will then gain an interest in toxicology and continue on as we have.
- Excellent resources and information provided.

14. Do you have curriculum resources you want to share through LifeSciTRC or CourseSource? If yes, please describe.
   - Systemic clinical toxicology (Suresh Kumar)
   - Have shared my syllabus for the research-based curriculum I think, already (BIO 4575 at App State) (Shea Tuberty)

15. Did you participate in the pre-webinar discussion?
   - Yes = 43% (3)
   - No = 57% (4)

16. If you didn’t offer any comments in the pre-webinar discussions, why not?
   - I was not available
   - Generally speaking, it is just a time crunch issue for me.
   - I had trouble logging in the first time and someone had to post for me. I didn't want to be a bother. I didn't try logging in again -- maybe it was fixed, but I didn't try again. It just seemed like one more thing to log into and I didn't take the time to do so. Sorry.

17. If you did participate in the pre-webinar discussion, did you find the pre-webinar discussion informative?
   - Yes = 67% (2)
   - No = 33% (1)

18. Would you be interested in attending more Toxicology Curriculum webinars in the future?
   - Yes = 100% (7)
   - No = 0% (0)

19. Do you have any suggestions for future webinar topics?
   - Emerging chemicals, exposome and toxicology (Judith Marsillach)
   - I love discussing alternative assessments and successful/creative assignments. (Elizabeth Thompson)
Attachment 2: Toxicology Curriculum Webinar Series Evaluation Aggregate (September 2021 – April 2022)

- Please include practical modules on insilico methods and toxicity modelling.
  (Suresh Kumar)
TOXICOLOGY CURRICULUM WEBINAR SERIES
EVALUATION SUMMARY

PURPOSE

The Toxicology Curriculum Webinar Series, conducted from September 2021 through April 2022, consists of seven 1-hour programs that were developed by members of the Society of Toxicology (SOT) who were recommended by the Faculty United for Toxicology Undergraduate Recruitment and Education (FUTURE) Committee.

The purpose of the webinar series, which is based on the SOT Undergraduate Toxicology Learning Framework, is to provide resources and instruction to help undergraduate faculty integrate core principles of toxicology into courses that align with toxicology. The webinars were held as virtual meetings and were recorded and archived on the SOT website (www.toxicology.org/education/edu/ncabr.asp) for ongoing use by undergraduate faculty.

Following the last installment of the webinar series, an evaluation to obtain initial feedback from participants was conducted with input submitted by April 22, 2022. Because it is known how incredibly busy undergraduate faculty are and how difficult it is to both review and implement webinar content in the midst of an ongoing semester, the project team determined a follow-up evaluation would be conducted in January 2023 after faculty had had more time to view the webinar series and to implement its content. In the months leading up to the final evaluation in January 2023, additional undergraduate faculty in North Carolina were invited to view the webinars online in recorded form in order for the project team to gather broader input on the series.

On January 26, 2023, an electronic evaluation was sent via ToXchange to the Toxicology Curriculum Webinar Series Discussion Group and via email to the new members of the North Carolina Higher Education Faculty and Mentor Network who were not members of the Toxicology Curriculum Webinar Series Discussion Group. All were asked to respond with their feedback by February 3, 2023.
DEMOGRAPHICS

From the survey, 11 responses were received with the majority of respondents residing in North Carolina (See figure 1.)

![Figure 1. Geographical location of respondents.](image)

Of the respondents, the majority were in Full Professor and Associate Professor positions at their institution. (See figure 2.)

![Figure 2. Professional title of respondents](image)
Respondents represented various departments within their institution. Academic departments reported were:

- Biological Sciences
- Biology
- Biomedical Sciences
- Natural Sciences, Pharmacy, and Health Professions
- Chemical and Environmental Sciences
- Science and Math
- Clinical and Toxicological Analysis

TOXICOLOGY CURRICULUM WEBINARS

The Toxicology Curriculum Webinar Series was comprised of the following seven webinars and specific concepts in toxicology.

- Webinar 1 – An Introduction to the Core Concepts of Toxicology
- Webinar 2 – A Focus on Evolution
- Webinar 3 – Biological Information – Toxicology and the Genome
- Webinar 4 – Pathways and Transformations of Toxicants, from Dose-Response to ADME
- Webinar 5 – Systems Toxicology
- Webinar 6 – Risk Assessment
- Webinar 7 – Culmination of Core Concepts to Teach Toxicology

In the January 2023 evaluation, respondents were asked to assess which webinars were the most useful for curriculum development; easiest to incorporate into courses; most challenging to incorporate into courses; and those that will expand or enhance what is already being taught.

SUMMARY OF RESULTS

Of the 11 respondents, 8 respondents either attended live or later watched the Toxicology Curriculum Webinars; 5 respondents were teaching toxicology in their curriculum prior to attending/watching; and 2 respondents began teaching toxicology concepts in their courses after attending/watching the webinars.
Attachment 3: Toxicology Curriculum Webinar Series Evaluation Aggregate (January 26, 2023)

As illustrated in the Figure 3, respondents found webinar 1. *Introduction of Core Concepts* the most useful webinar of the series followed by webinars 4. *Pathways & Transformations* and 6. *Risk Assessment*.

![Toxicology Curriculum Webinars Usefulness](image)

*Figure 3. Ranking of Toxicology Curriculum Webinars usefulness*

As illustrated in Figure 4, respondents found webinar 1. *Introduction of Core Concepts* the easiest webinar to incorporate into courses, followed by webinar 6. *Risk Assessment*.

![Ease in Incorporating Toxicology Curriculum Webinars](image)

*Figure 4. Ranking of Toxicology Curriculum Webinars easiest to incorporate*
As illustrated in Figure 5, respondents found webinars 2. *A Focus on Evolution* and 5. *Systems Toxicology* the most challenging to incorporate into courses.

![Toxicology Curriculum Webinars Most Challenging to Incorporate](image)

*Figure 5. Ranking of Challenging Toxicology Curriculum Webinars to incorporate*

As illustrated in Figure 6, respondents found webinars 4. *Pathways and Transformations of Toxicants, from Dose-Response to ADME* and 6. *Risk Assessment* expanded/enhanced what they were already teaching.

![Toxicology Curriculum Webinars that Expanded/Enhanced a Course](image)

*Figure 6. Ranking of the Toxicology Curriculum Webinars that expanded/enhanced what was already taught*
However, respondents who did not already teach toxicology concepts in their courses believed that webinars 1. Introduction of Core Concepts, 4. Pathways and Transformations, and 6. Risk Assessment would expand/enhance what they are already teaching.

**STUDENT REACTIONS TO TOXICOLOGY CONCEPTS**

When asked the following — *If you have incorporated toxicological concepts from the webinars into your existing courses - even though you did not watch the curriculum webinar series - have students approached you about careers in toxicology? If so, what specific career areas?* — Three respondents shared they had a student approach them about careers in toxicology. One student was interested in public health, 1 student was interested in graduate school with no clear goal, and 1 student shared their interest in toxicology was due to their exposure to a high school teacher who had a background in toxicology.

**IMPEDEMENTS TO INCORPORATING TOXICOLOGICAL CONCEPTS**

Respondents shared that “time” was a major impediment for incorporating toxicological concepts into curriculum that faculty currently are teaching in their discipline. Having to view the content, learn new materials, plan and develop course content would take more time than they could allow due to their current course load and other responsibilities.

**COMMENTS**

“This was a great series that got the community together regularly, hopefully generating a community of practice in toxicology education that continues into the future. What is next?”

“The webinars, ToxMSDT, syllabi and slide decks available through SOT have been a tremendous resource, please keep building them!

“They [the webinars] provided ways for me to present or make connections for my students on those topical areas.”

“Helpful in the development of a new elective course - introduction to toxicology course. If approved.”

“Thanks for your effort and great work towards improving education.”

“It [the webinar] was very useful for faculty, although not very engaging for students. I recommend working with an instructional designer so these webinars can include more of an active learning component and less of the "talking head" approach.”

“Coming into Toxicology from human genetics/biochemistry and no formal tox courses, the webinars have been very useful to not only increase my own tox knowledge but have enabled me to integrate tox concepts into multiple courses and offer a special topics in toxicology & biochemistry course.”
“These concepts are sometimes the most difficult and intimidating for students.”

“Exercises for lab illustrating tox principles would be helpful.”

“In fact, I [am] retired from the University and did not give classes anymore. But the idea of the Series is great because it emphasizes the need of other sciences for toxicology and also applied toxicology concepts. Congratulations. I attended only part of some of the seminars.”

“Honestly, I am always fascinated in assessments, including fun toxicology related assignments, and how instructors use them and which ones they feel are most/least successful.”
North Carolina Higher Education Faculty and Mentor Network Meeting
Friday, January 6, 2023
Syngenta RTP

11 Respondents out of 13 Attendees (not including the three program staff).
There were five others who registered to attend but then did not.

Evaluation

1. What is the ideal frequency for Network meetings like the one today? Please select only one option:
   a. Once every 2-3 months = 28%
   b. Once every 6 months = 64%
   c. Annually = 9%
      • Once every four months (Fall/Winter/Spring)
      • Once every 6 months prior to classes (January/August)

2. What is the best format for future Network meetings?
   a. Face-to-face = 45%
   b. Virtual = 0%
   c. Both = 55%
      • Consider a satellite session in association with NCSOT
      • Maybe every other meeting is virtual

3. If we were to convene more often, what topics would you want us to address that would help undergraduate educators infuse the core concepts of toxicology into their curriculum?
   • Discuss what virtual resources are available, maintenance of those resources and access
   • Identifying opportunities for internships, visits to tox labs, etc. especially for smaller universities
   • Available resources
   • Provide consulting or advice on how to incorporate elements of toxicology in common courses found in Biology or Chemistry. Remind or show members the resources that are available.
   • I would like to hear from NCSOT & SOT about upcoming opportunities for undergraduates. I would love to see us compile a list of local organizations who may have opportunities for undergraduates (i.e. internships). I would also love to share ideas about assignments we use in our courses that encourage a better understanding of toxicology.
   • Environmental and occupational toxicology with a focus on human health implications
   • Brainstorming/breakout groups to discuss opportunities for undergraduates and their faculty mentors/advisors.
   • Possible lesson plan development, key concepts with support from agency/organization scientists
   • Demonstration of how some professors incorporate toxicology in their biology and chemistry classes.
Attachment 4: Network Meeting Evaluation Aggregate (January 6, 2023)

- Speaking to toxicology graduate students about what they wish they had learned from undergrad
- EPA/FDA requirements and the studies involved for registration of drugs/products
- Laboratory Ideas (Full Course)
- Course ideas (1 credit)
- List of undergraduate summer research opportunities
- It might be useful to host a meeting in which attendees from colleges with needs could discuss possibilities with some SOT member attendees willing to make visits to give lectures on specific topics or talk with students about careers in tox — i.e., a meeting to establish specific contacts.

4. Overall, how would you rate today's meeting? (5 is best; 1 is worst)
   5 = 28%  4 = 73%

5. What are your thoughts regarding the format and length of today's meeting?
   - Think it was good. While I think the Syngenta aspect is interesting, I would have liked to have more discussion on the NCABR work and discuss action items.
   - Format and length were good. Maybe a bit longer for the group discussion since we didn’t really get to the questions.
   - I thought it was appropriate. I loved the tour.
   - Slightly too long but really appreciated all the various aspects that were incorporated and I was very fascinated by all of the research at Syngenta.
   - The program was outstanding and well planned.
   - Perfect length 1/2 to 2/3 day. However, it may have been more productive with an additional 30-60 minutes where faculty could speak with SOT and others to develop action plans for getting toxicologists on to campus and speak with students.
   - Format and length were fine for a meeting of this type (could be different if we met more than two times a year).
   - Wish we had more time to discuss between each other strategies for teaching toxicology at the undergrad level. However, for our 1st meeting in-person, I believe this was a great 1st step in getting us together.
   - Fine
   - We should have spent more time with discussions!
   - Everyone has tons of experience with toxicology (teaching). I wanted this interaction.

6. Additional comments/suggestions:
   - Hope you can offer these programs across the state.
   - Great job. Perhaps have some of the meetings at one of the institutions.
   - Truly enjoyed meeting face to face!
   - Perhaps more folks would engage with a hybrid option (if possible).
   - I think the next meeting should focus on discussing strategies for teaching toxicology – meet in person over lunch.
   - I think having the meeting at a company was a great idea! In the future, maybe have a meeting at a government toxicology agency (NIEHS/EPA)
   - Great job of bringing scientists together to learn and refresh
   - Enjoyed lectures and tour.
   - The talks by the Syngenta folks were generally interesting but lacked connection to toxicology. Same with the tour, although, I found it interesting.
   - Continue to create opportunities to connect professional toxicologists from various sectors (government, industry, non-governmental organizations) with undergraduate instructors. Each of these sectors
represented in the Research Triangle Park, so there are ample opportunities to connect with local experts. Instructors could arrange/schedule guest seminars or lectures to bring in outside toxicologists to share their work, including their path to toxicology.

- The Network is a great resource for building connections, especially in partnership with the Society of Toxicology. I greatly appreciate the opportunity provided by the network to meet educator that I would not likely cross paths in my day-to-day research activities. I very much look forward to providing support however needed to the network to see more connections established to raise awareness about careers in toxicology.
North Carolina Higher Education Faculty and Mentor Network
Friday, May 19, 2023
NIEHS
Respondents = 13

1. Would you like to continue meeting as a Network?
   Yes = 100% (13)
   No = 0%
   Not sure = 0%

2. What is the ideal frequency for Network meetings like the one today?
   Once every 2-3 month = 8% (1)
   Once every 6 months = 77% (10)
   Annually = 15% (2)

3. What is the best format for future Network meetings?
   Face-to-face = 77% (10)
   Virtual = 0%
   Both = 23% (3)

4. What are your thoughts regarding the format and length of today’s meeting?
   - Appropriate
   - Good length of time
   - Just right
   - Great length, good discussion
   - Very good
   - It was good, it might help to list a set of key goals (key words) to focus on
   - Format was great and time was well-managed
   - I enjoyed the format of today’s meeting. I think that going forth, roundtable discussion topics should be pre-planned, followed by a few moments for open discussion.
   - If meeting two times a year, 2 four-hour meeting, aligns makes sense
   - Today worked well, good timing, lots of opportunity for discussion
   - Great! Really enjoyed the opportunities for discussion.
   - Good
• Perfect length. If they want to trim it, we could meet at 1 pm (after lunch) and go from there.

5. **What topics would you like addressed in future meetings?**
   - Toxicology in relation to air pollution
   - Pathways to industry internships for undergraduates
   - How to expand connections with more junior faculty
   - Networking and mutual interest and how toxicology program can be implemented in at undergraduate level
   - Risk assessment for the toxic compounds in recent news media
   - Career opening in SOT, keywords to add to resume
   - Economic toxicology
   - DEI in the larger field and within related majors
   - How to best capture undergraduates, success stories
   - Possibilities/challenges for incorporating internships into curriculum, allowing students to get course credit.
   - Focus on undergraduate toxicology connections (December meeting)

6. **Overall, how would you rate today’s meeting?** (5 is best; 1 is worst)
   - 5 = 69% (9)
   - 4 = 31% (4)

7. **Additional. Comments/suggestions:**
   - Opportunities for fellowship and post-graduate opportunities
   - Enjoyed the information presented, very informative and helpful. I will introduce the information to my undergraduate students and encourage them to become involved. Lots of good stuff.
   - Enjoyed the friendly inviting atmosphere
   - Thanks!
   - Nice to be in person
   - We should have specific topics to discuss during roundtable discussions.
   - Everyones’ contact information