Nomination of

David M. Collard
Georgia Institute of Technology

for the

University System of Georgia
2017 Felton Jenkins, Jr. Hall of Fame Faculty Awards

December 2016

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Georgia Institute of Technology

Office of the Provost and Executive Vice President for Academic Affairs

December 6, 2016

Dear Members of the Board of Regents Awards Committee:

It is my distinct pleasure to nominate Professor David Collard for the *University System of Georgia Felton Jenkins, Jr. Hall of Fame Faculty Award*. Dr. Collard is a Professor in our School of Chemistry and Biochemistry and he serves as Associate Dean for Academics in the College of Sciences. He is a strong candidate for this award, and it is my pleasure to introduce him to you.

A member of the faculty at Georgia Tech since 1991, Dr. Collard is a leader in educational innovation and research in STEM education. His commitment to improving student learning ranges from engaging students in his classes through evidence-based teaching strategies to involving undergraduates in cohort research experiences. He has maintained an astounding portfolio of federal and corporate support for programs that provide STEM students with financial aid, learning support, and opportunities to engage in research. In addition, David provides leadership to a long-standing nationwide faculty development program that has impacted thousands of STEM educators – who in turn have taught more than two million students.

David's accomplishments in teaching are outstanding in every respect. He has the unique distinction of having received all three of the Institute's top teaching awards: the Class of 1940 W. Roane Beard Outstanding Teacher Award (which focuses primarily on early career faculty), the Class of 1940 Howard Ector Outstanding Teacher Award (for more established faculty), and the Eichholz Award (for outstanding instruction of introductory classes). He is also recipient of the Georgia Tech Class of 1934 Outstanding Use of Educational Technology Award and the Outstanding Ph.D. Advisor Award. In addition, David's work in undergraduate education has garnered awards from the National Science Foundation, the Camille and Henry Dreyfus Foundation, and the Research Corporation for the Advancement of Science.

I believe Professor David Collard to be a worthy recipient of the *University System of Georgia Felton Jenkins, Jr. Hall of Fame Faculty Award* and recommend him to you with great enthusiasm. David's efforts to enhance student learning in the courses he teaches at Georgia Tech as well as in STEM classrooms and labs throughout Georgia and across the country have achieved remarkable results. Please give him your highest consideration for this award.

Sincerely,

Rafael L. Bras
Provost and Executive Vice President for Academic Affairs

November 27, 2016

To the USG Faculty Awards Selection Committee:

It is a pleasure to support the nomination of my colleague David Collard for the *University System of Georgia Felton Jenkins, Jr. Hall of Fame Faculty Award*. As you will see in the supporting documentation, David is widely recognized as an exceptionally talented instructor who has dedicated a significant portion of his professional endeavors to improving both undergraduate and graduate education at Georgia Tech.

David's Instructional Role. For a long stretch of time, David took a leading role in the School's introductory organic chemistry sequence (CHEM 2311 and 2312), choosing to teach our large on-sequence courses with enrollments of well above 100 students, and as high as 260. Students enrolled in the class are mostly in the biology, chemical engineering and biomedical engineering majors, with fewer chemistry and biochemistry majors, as well as additional pre-medical students. Over this period of time, David was teaching more undergraduate students than any other member of the tenure-track faculty of the School. The material in these classes is complex, highly interrelated, and often abstract. David has a highly developed sense of empathy for his students, and he has worked tirelessly on developing an approach to engage them though a broad set of pedagogical methods. Students comment on the enthusiasm that David brings to his teaching:

> *"the way he approached the material and explained it made it much easier for the class to understand. He approached the material like a student would think about it."*
>
> *"My professor did a lot to help us succeed in this class."*
>
> *"Dr. Collard was very enthusiastic about the course. He held review sessions several times outside the class to help us prepared for test"*
>
> *"The professor explains everything clearly, and is willing to help student understand the material. He is an amazing professor!"*

More recently, David has taken on the instruction of senior level (CHEM 4341) and graduate level (CHEM 6371) classes in which students learn to determine the structure of complex organic molecules using advanced spectroscopic techniques. Over the last six years, we have seen an increase in the number of students enrolled in CHEM 4341 from ~### (2000-2000) to ### (this semester), in part, I am sure, because of the high regard that students have for the nature and style of the course that David has developed.

Course Activities. David's use of a variety of teaching technologies forms an integral part of his courses. He has designed these to allow students to begin their exploration of new material from a number of different perspectives, thereby accommodating students' various learning styles. His course websites provide an organization for the course along with an integrated suite of resources that students use on a frequent basis and in an active manner (e.g., learning objectives, class notes, pre-lecture quizzes, practice exams, online practice quizzes, animated homework and exam answer keys).

David's major motivation in adopting and developing new technologies in the Organic Chemistry sequence was his observation of the number "C"s given previously in organic chemistry classes at Georgia Tech, and a related issue of how many D-F-W grades are assigned in traditional organic chemistry classes across the entire nation. He was concerned that students were not using the textbook as a resource. His major contention was that lack of frequent encounters with the textbook constituted a lost opportunity to engage students, and that too many bright and capable students ended up with a "C" essentially because of poor study habits. He also felt that is there little value in using class time for didactic lecturing to simply transfer knowledge from his notes to the students' notes.

David's holistic approach to enhance his student's study habits begins before each class period with students completing pre-lecture quizzes, with answers submitted via the Institute's learning management system. His innovation predates the current enthusiasm for "flipping" the classroom. David published a peer-reviewed paper on the method and its impacts in the *Journal of Chemical Education* way back in 2002 and he has continued to evolve this approach. These quizzes, originally dubbed as "HWebs", are designed so that students read the textbook for a preview of material covered in the next lecture. While completion of these assignments requires a concerted effort throughout the entire semester, students see the benefit of this frequent and early engagement with the textbook:

> *"HWebs were the best part because they forced you to keep up."*

> *"... the assignments were absolutely crucial to understanding the material, and the HWebs were really helpful"*

> *"HWebs were somewhat annoying, however I think it is a great idea in keeping the students involved and knowledgeable going into the lecture."*

> *"HWebs helped me stay caught up with the course material and learn as I went along"*

In class, students make us of downloadable "skeleton" notes (approximately 600 pages for the two-semester sequence) which are fleshed out throughout the class period. David has strong views on the use of PowerPoint in lectures and how it can lead to a student disengagement. David's approach engages students in a much more active learning style such that they are drawing chemical structures, sketching reaction pathways, answering questions and contributing to a discussion throughout the lecture. He was an early adopter of tablet PCs for teaching, long before the appearance of iPads, so that students are viewing a presentation that is dynamic and engaging. Students write a little, and draw a lot – an important component to gaining mastery in organic chemistry. They write and draw only what best-supports mastery of the material, they are not blindly copying notes or faced with a passive PowerPoint slide. This provides students with structure, focuses them on the most important topics, lets David step away from the podium in support of entering into an exchange of ideas with students, and provides time to work problems that support the development of new ideas. David's notes are now used by other instructors for the CHEM 2311-2312 sequence. Students have reported:

> *"Prof. Collard presented the material in a very clear and effective way. The notes were exceptional."*

> *"I have never had a class with "fill in the blank" notes but I really found them to be effective."*

David was also a very early adopter of Personal Response Systems (PRS). In 1996, he attended a Research Corporation Cottrell Scholars conference in Tuscon, AZ, where Eric Mazur presented his early perspectives on the use of PRS in teaching Physics at Harvard. David returned from the conference with great enthusiasm to explore the use of PRS in lower division chemistry classes. Prior to broad campus support for PRS, David and Kent Barefield received a Technology Fee grant to introduce PRS to Kent's freshman class and David's sophomore level classes. While PRS is used in a variety of different fashions by individual instructors, David uses it in large classes to enter into a Socratic exchange with students and to develop new concepts throughout the class period. He also provides ungraded online quizzes for each chapter so that students can assess their own understanding of material.

> *"I like the PowerPoint style note taking, and the PRS questions are good too"*

> *"He also provided many resources to understand concepts fully"*

Teaching Laboratories and Research Laboratories. David has worked with the Directors of our laboratory program to insure that our laboratory courses reinforce the concepts covered in lecture courses. He has also gone to great lengths to equip the instructional labs with modern instrumentation that provides our students with hands-on experiences with techniques which assure that they are optimally prepared for the work place or graduate school. Most impressively, his efforts have resulted in three NSF awards for the purchase of instrumentation for: thermal analysis, nuclear magnetic resonance, and electron spin resonance. A more recent NSF-funded initiative led to the development of a common thread that links the laboratory courses that are taken by chemistry majors.

David has kept a stream of undergraduates engaged in his research program in semiconducting organic materials and biopolymers. A significant portion of his papers have undergraduates as coauthors (some of these are identified in his condensed vita). His undergraduate researchers have gone on to top-notch graduate programs.

David's impact on undergraduate teaching reaches far beyond Georgia Tech. David is a co-director of a 15-year $10M program of NSF grants that provide workshops and online learning communities for faculty at 4-year and 2-year colleges across the nation. This program is a vital component of the chemical education landscape in the U.S. in that over 3,000 faculty members from over 800 institutions have attended workshops and taken new pedagogies and techniques back to their classroom. The scope and longevity of this program are truly amazing – since their attendance at the workshops, the faculty participants will have taught a combined total of more than two million students!

Teaching Evaluations and Students Comments. The results of the Institute's Course Instructor Opinion Survey (CIOS) teaching evaluations attest to David's effectiveness as an instructor. Summary results are included with this nomination. *His scores have consistently ranked at the top of those in the School* (and I imagine, the entire Institution). It is notable that his average rank for "Question 10" (the instructor was an effective teacher) has averaged 4.7 out of 5 for the last 25 years, during which he has taught courses that range from the largest of our "service" classes to specialized graduate classes.

David receives extremely positive written comments in the CIOS, with frequent words of thanks and kudos for his efforts and effectiveness in motivating students:

> *"You really made me enjoy chemistry! :)"*

> *"Fantastic teacher. Explained course material very well. Going to class paid off for once."*

> *"Thanks for a great course. I never thought I'd see the day when I could honestly proclaim that I *like* organic chemistry."*

"He believes in his students, and believed in me…"

David has been extremely analytical in determining the learning outcomes of his classes through the administration of pre/post tests and nationally standardized exams that are produced by the American Chemical Society. David's design of his classes, and each component (e.g., syllabus. lectures, homeworks, exams), is very, very deliberate, and data driven.

I would be remiss if I did not mention David's work on academic program development, student scholarships and experiential learning. Briefly:

- For 15 years he maintained NSF support for our department's Research Experiences for Undergraduate program which welcomes visiting undergraduate students to campus for an immersive summer research experience.
- He has established an NSF-supported multidisciplinary freshman/sophomore Living Learning Center that focuses on early student engagement in research.
- David led the School's initiatives to expand its doctoral program though curriculum revision, enhanced recruitment, and financial aid awards. During his tenure as Director of Graduate Students/Associate Chair, the department more than doubled the size of the Ph.D. program (it is now ca. 12th in size among the nation's ~200 Ph.D. program in chemistry). This represented the largest growth in the size of the graduate program *in the entire nation* over this period. This initiative was supported by a long series of grants, amounting to over $3.5M, that David obtained from the U.S. Department of Education.
- He marshalled the department's efforts to establish a B.S. program in Biochemistry that now has 215 majors, making it the second-largest major in the College of Sciences.

In addition to his outstanding contributions through classroom instruction and program leadership, David has maintained an active and productive research effort funded by NSF and NIH. He has a strong record in mentorship of doctoral students, who have gone on to productive positions in industry (including positions in Georgia with Coca Cola, CIBAVision/Alcon, Kimberly Clark, Femasys Medical Devices, and BioLabs), the federal government, and academia.

The breadth and impact of David's activities related to teaching and the creation of opportunities for student to engage in experiential learning are astounding. David Collard would be superb choice as the recipient of the 2017 *Felton Jenkins, Jr. Hall of Fame Faculty Award*. I hope that you will give this nomination careful consideration.

Sincerely,

M.G. Finn
Professor and Chair
School of Chemistry and Biochemistry

To: USG Faculty Awards Committee
From: Paul M. Goldbart, Dean and Sutherland Chair, College of Sciences, Georgia Tech
Subject: Support for nomination of David Collard
Date: 1 December, 2016

Based on our almost six years of close interactions on numerous aspects of education, I am delighted and indeed honored to support Provost Bras' nomination of David Collard for the *Felton Jenkins, Jr. Hall of Fame Faculty Award.* In his letter, Chemistry and Biochemistry chair M. G. Finn provides insights into David's commitment and effectiveness in teaching in the chemistry curriculum. Here, I discuss additional themes that relate to David's role as my college's Associate Dean for Academic Programs and which relate to students' experiences in science and mathematics courses that are taken by every single Georgia Tech undergraduate.

David constructed and directs our college's **undergraduate recruiting initiative**. A series of year-round campus visits and outreach to high schools is focused on increasing the number of applicants to science majors. Initiatives with our Office of Admissions and Office of Scholarships and Financial Aid aim to increase the yield of students who matriculate. David leads a small team that puts on two very exciting marquee recruiting events each spring that each attract 300-500 guests and have a strong record of increasing our college's yield.

The development of a **B.S. degree in Neuroscience** is motivated by deep student interest in this major. Engaging David on this vital task harnesses well his prior experience in leading the development of our large Biochemistry major. The interdisciplinary nature of neuroscience means that he has had to engage a broad selection of departments, identify laboratory space (requiring a renovation project), and establish a staffing model (which requires the hiring of new faculty, support staff and teaching assistants). The proposal was recently submitted to USG.

Given the College of Sciences' role in teaching USG core classes in laboratory science and mathematics to all undergraduates, we have embarked on a series of activities to provide **formative assessment and summative evaluation of teaching**. David has instigated a mid-semester evaluation of our courses, and he will embark on a new faculty-led process. Improving the instruction of foundational classes is a measure that we expect to improve our **retention** and time to degree (of importance to the Complete College Georgia initiative), and to attract transfer students and students from other majors. David's development of living learning communities has already proven to be an inspiring and successful retention strategy.

David is building on initiatives that he began in the School of Chemistry and Biochemistry to insure that, college-wide, our academic programs **promote inclusivity and diversity** in training the future STEM workforce. This includes diversity initiatives for graduate recruiting and a diversity-focused Research Experience for Undergraduates program in Physics.

David directs our **Open Educational Materials** project to support faculty initiatives on teaching without a textbook. This, together with initiatives to increase our **web-based instruction** of core science and mathematics courses, will support student learning while also addressing cost.

David is passionate about improving STEM education and highly effective at it. His classroom instruction, second to none, is the result of extensive reflection, analysis of student performance, and long hours working out the most effective way to communicate a concept or weave together an entire class. His leadership of our academic programs benefits greatly from those same analytical skills, balanced with his deep intuition for and creativity in program building, and a persuasiveness to obtain (federal agency, private donor, campus etc.) resources to support this vision.

DAVID M. COLLARD

School of Chemistry & Biochemistry, Georgia Institute of Technology
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Education

B.Sc. (Hons.), Chemical Sciences, 1983, University of East Anglia, U.K. (A. McKillop).
Ph.D., 1989, Chemistry, University of Massachusetts, Amherst (C. Peter Lillya).
Post-Doctoral Fellow, 1989-91, University of Texas at Austin (Marye Anne Fox).

Professional positions

Georgia Institute of Technology, College of Sciences
Associate Dean, 2010-present.
Georgia Institute of Technology, School of Chemistry & Biochemistry
Professor, 2005-present (Associate Chair, 2005-2010); Associate Professor, 1997-2005 (Director of Graduate Studies, 1997-2005); Assistant Professor, 1991-1997.

Current fields of interest

- *Polymer chemistry:* Semiconducting organic materials; polymers for bioengineering.
- *STEM education:* Faculty development workshops and communities; broadening participation in research; undergraduate and graduate instruction in organic chemistry.

Teaching experience

1991-present: 67 courses; 4,761 students enrolled (class size range: 10-264), most significantly:

- *Organic Chemistry I and II* (CHEM 2311 and 2312), and *Laboratories [33 sections, 3,187 student enrolled]*: The introductory year of organic chemistry; taken by biology, biomedical engineering biochemistry, chemical engineering and chemistry majors, and other pre-health students.
- *Applied Spectroscopy* (CHEM 4341) and *Organic Compounds* (CHEM 6371) *[16 sections, 388 students]*: Advanced undergraduate and graduate-level courses on the use of modern spectroscopic methods to determine the structure of organic compounds.

Leadership of on-campus experiential learning programs

- National Science Foundation Research Experience for Undergraduates (REU) program in Chemistry & Biochemistry; Director, 2002-2015; Co-director 1996-2001.
- 3M Undergraduate Summer Research Program; Director, 2010-present.
- National Science Foundation Scholarships in STEM & Living-Learning Community; Director, 2009-2014; Co-director, 2015-present.
- U.S. Department of Education Graduate Assistantships in Areas of National Need (GAANN) programs (in Chemistry & Biochemistry, Polymer Science and Engineering, and Molecular Biophysics); Director, 2000-2016.

These programs have engaged more than 1,000 STEM students in undergraduate research, financial aid scholarships, a living-learning community, and academic support.

Leadership of national faculty development program

- NSF-supported faculty development program *Chemistry Collaborations, Workshops and Communities of Scholars* (cCWCS); Co-director, 2001-present.

This program provides weeklong curriculum workshops that have engaged more than 3,000 faculty members from over 800 institutions from throughout the U.S.

Individual student research mentorship

23 Ph.D. graduates (+6 in progress), 10 M.S. graduates (+1 in progress), 37 undergraduate researchers.

Honors, awards or recognitions

Georgia Tech Outstanding Professional Education Award, 2011.
Georgia Tech Class of 1940 Howard Ector Outstanding Teacher Award, 2009.
Georgia Tech Eichholz Award (for outstanding instruction in foundational courses), 2008.
Georgia Tech Class of 1934 Outstanding Use of Educational Technology Award, 2008.
Georgia Tech Outstanding Ph.D. Advisor Award, 2005.
Omicron Delta Kappa, 2001
Georgia Tech Class of 1940 W. Roane Beard Outstanding Teacher Award, 1997.
National Science Foundation CAREER Award, 1995-1999.
Research Corporation for Scientific Advancement Cottrell Scholarship, 1994-1996.
Amoco Foundation–Georgia Tech Junior Teaching Excellence Award, 1993.
Lilly Foundation Teaching Fellowship, 1992-93.
Camille and Henry Dreyfus Foundation New Faculty Award, 1991-96.

Selected published educational media

"Organic Chemistry Testbank," D.M. Collard; in support of "Organic Chemistry," by W.H. Brown, C. Foote, B.L. Iverson and E. Anslyn: Brooks-Cole.

"Animated Organic Chemistry Mechanisms," D.M. Collard; in support of "Organic Chemistry," by J. Smith; and "Organic Chemistry," by F.A. Carey: McGraw-Hill.

"Online Organic Direct Tutorials," D.M. Collard; in support of "Organic Chemistry," by J.E. McMurry: Cengage Learning.

"Molecular Modeling Using ChemOffice," D.M. Collard and H.M. Deutsch: Jones and Bartlett, Inc.

Selected peer-reviewed research publications with undergraduate co-authors

111 publications total; undergraduate co-authors underlined.

"Competition Between π–π and C-H/π Interactions: A Comparison of the Structural and Electronic Properties of Alkoxy-Substituted 1,8-Bis ((propyloxyphenyl) ethynyl) naphthalenes," B.E. Carson, T.M. Parker, E.G. Hohenstein, G.L. Brizius, W. Komorner, R.A. King, D.M. Collard, C.D. Sherrill, *Chemistry–A European Journal* **2015**, *21*, 19168-19175.

"Molecular Engineering of Solution-Processable Bithiazole based Electron Transport Polymeric Semiconductors," B. Fu, C.-Y. Wang, B.D. Rose, Y. Jiang, M. Chang, P.-H. Chu, Z. Yuan, C. Fuentes-Hernandez, B. Kippelen, J.-L. Brédas, D.M. Collard, E. Reichmanis, *Chemistry of Materials* **2015**, *27*, 2928–2937.

"Synthesis and Characterization of Poly(5,8-Quinoxaline Ethynylene)s," K.B. Woody, E.M. Henry, S. Jagtap, D.M. Collard, *Macromolecules* **2011**, *44*, 9118–9124.

"Synthetic Approaches to Regioregular Unsymmetrical Dialkoxy Substituted Poly(1,4-Phenylene Ethynylene)s," R. Nambiar, K.B. Woody, J.D. Ochocki, G.L. Brizius, D.M. Collard, *Macromolecules* **2009**, *42*, 43–51.

"Synthesis, Properties, and Tunable Supramolecular Architecture of Regioregular Poly(3-alkylthiophene)s with Alternating Alkyl and Semifluoroalkyl Substituents," B. Wang, S. Watt, M. Hong, B. Domercq, R. Sun, B. Kippelen, D.M. Collard, *Macromolecules* **2008**, *41*, 5156-5165.

“Synthesis and Modification of Functional Poly(lactide) Copolymers: Towards Biofunctional Materials” D.E. Noga, T.A. Petrie, A. Kumar, M. Weck, A.J. García, D.M. Collard, *Biomacromolecules* **2008**, *9*, 2056-2062.

“Stacked Conjugated Oligomers as Molecular Models to Examine Interchain Interactions in Conjugated Materials,” K.M. Knoblock, C.J. Silvestri, D.M. Collard, *Journal of the American Chemical Society*, **2006**, *128*, 13680-13681.

Selected contributions to chemical education literature and conferences

“cCWCS as a Catalyst for Curriculum Reform,” D.M. Collard, presented at the Biennial Conference on Chemical Education, Greely, CO, August 2016.

“Stategic Targeting of Diverse Cohorts: A Glimpse into the Georgia Tech REU Program,” S. France, D.M. Collard; J. Tyson, K. Johnson, presented at the 251st National Meeting of the American Chemical Society, San Diego, CA, March 2015.

“From the Textbook to the Lecture: Improving Pre-Lecture Preparation in Organic Chemistry,” D.M. Collard, S.P. Girardot, H.M. Deutsch, *Journal of Chemical Education* **2002**, *79*, 520-523.

“Synthesis and Spectroscopic Analysis of a Cyclic Acetal: A Dehydration Performed in Aqueous Solution,” D.M. Collard, A.G. Jones, R.M. Kriegel, *Journal of Chemical Education* **2001**, *78*, 70-72.

“Polymer Chemistry in Science Museums: A Survey of Educational Resources,” D.M. Collard, S. McKee, *Journal of Chemical Education* **1998**, *75*, 1419.

Grant support

- ***Organic chemistry and polymer research:*** Support for disciplinary research includes multiple grants from the National Science Foundation and NASA for work in semiconducting organic materials, and from the National Institutes Health for work in plastics for bioengineering.
- ***Experiential learning programs and broadening participation:*** NSF grants support our long-running Research Experiences for Undergraduates (REU) program (1996-2014, 7 grants, $1.4M; now continuing under the leadership of a colleague) and Scholarships in STEM (S-STEM) financial aid program (2 awards, 2009-present, $1.2M). Grants from the U.S. Department of Education have supported broadening participation in graduate education (6 awards, $3.4M).
- ***Chemical education:*** NSF grants have supported the purchase of instructional instrumentation and curriculum development (4 awards, $0.6M). NSF has also provided continuing support (2001-present) for the cCWCS national faculty development program (4 awards, $10.1M).
- ***Corporate and foundation support for educational initiatives:*** Additional grants ($0.7M) have been received from 3M, the Camille and Henry Dreyfus Foundation, the Arnold O. Beckman Foundation, the Lily Foundation, the American Chemical Society and the Research Corporation for Scientific Advancement.

Symposium organizer: Teaching and learning

- Biennial Conference on Chemical Education – 2004 (Ames, IA), 2006 (West Lafayette, IN), 2008 (Bloomington, IN), 2010 (Denton, TX), 2012 (State College, PA); 2014 (Allendale, MI); 2016 (Greely, CO).
- National Science Foundation/American Association for the Advancement of Science CCLI/TUES program meeting – 2013 (Washington, DC).
- National Meeting of the American Chemical Society – spring 1997 (Chicago, IL), fall 2007 (Boston, MA), fall 2010 (San Francisco, CA).

TEACHING AND LEARNING PHILOSOPHY

A neophyte reads Ernest Boyer

1991. As a new Assistant Professor, I enter the classroom for the first time, an expert in the field of my doctoral research. I am now facing 70 students and know that I have 800 pages to cover. Class performance on the first exam is "disappointing". What's to do? The students and I persevere, and at the end of the semester we emerge from the course largely unscathed. Yet I am left exhausted and wondering "what did they really learn?" My expertise in my thesis research does little to inform me about how to proceed.

Over the summer, my chair encourages me to apply to the Lily Foundation Teaching Fellow program in Georgia Tech's Center for Teaching and Learning. I spend my second year on the faculty in an invigorating program with the staff of the Center, a cohort of junior colleagues from a variety of disciplines, and a slate of guest presenters. We travel together to conferences, we debate, we are reviewed in class—and our perspectives evolve. We drink-in Ernest Boyer's recently published *Scholarship Reconsidered: Priorities of the Professoriate.*

With self-reflection, my teaching becomes more learner-oriented. It emerges as an endeavor that integrates with my disciplinary research under a broadened definition of scholarship that is especially apt for the research-intensive university. And a quarter-century later, the dog-eared Boyer on my "teaching" bookshelf continues to provide me with inspiration to further elevate teaching and learning as I continue my journey into academic leadership.

In the classroom: Metacognition, responsibilities and measurement

My students and I make some amazing discoveries in the classroom. Together, we seek to master new material based on content from earlier in the course and from elsewhere in the curriculum. An inquiry-guided and problem-solving constructivist approach empowers students to become, in turn, familiar, comfortable and creative with the course material.

Early in the semester of foundational classes, and without burdening the students too much ("no, this will not be on the test"), I introduce: (1) the concept of metacognition (based on Saundra McGuire's analysis of students' ability to accurately judge their own learning); (2) the revised verb-form of Bloom's taxonomy; and (3) Frank Christ's <u>*PLRS*</u> learning cycle. We *<u>P</u>review* material through the articulation of learning objectives and modest online assignments that students complete before every lecture. *"<u>L</u>ecture"* – moderately active, certainly not fully flipped – lets us explore topics. A carefully designed series of low-stakes PRS (personal response system) questions guides our learning and builds students' metacognitive skills. We *<u>R</u>eview* in low-stakes homework sets that build familiarity with materials so as to negate, for many, the need to "memorize". We *<u>S</u>tudy* by putting the material together in problems that have us clamber ever higher toward the rarefied atmosphere atop Bloom's pyramid.

I use pre/post tests in my classes to determine how a change in course delivery, or my approach to a particular concept, is reflected in the normalized learning gain ("Hake gain"). The introduction of pre-lecture reading assignments led to a large jump in learning gains, along with a significant decrease in the number of "C" and "D" grades in the class. This supports the idea that frequent consultation with the textbook assists students who might otherwise not be so engaged with the material. The assignments had only a small effect on the number of "A" grades, suggesting that "B+" and "A" students already engage effectively with the material.

Further determination of effectiveness may be gained from scores on the American Chemical Society's standardized exam that I use as the final for Organic Chemistry II. That so many students score high against the national norms for this exam supports a grade distribution for the course that has few "D"s and "F"s (along with a vanishingly small rate of "W"s), with an overall "DFW" rate of less than 10%.

No student will be surprised by what is expected when they take a first look at an exam in my courses. A homework assignment right before each exam will consist of a practice exam (again, low stakes). If to err is human, then "to reflect (on the error) is divine" [Dr. Christina Barbieri] – and learning from mistakes is, sometimes, a most powerful way to learn.

This approach addresses the misconceptions that many students bring to the organic chemistry course ("it's hard", "med schools require an 'A'", "memorize!"). While student's have a responsibility to engage frequently and thoughtfully with the material, my aim is to make sure that every student knows that "I've got your back". If you fail, then I have failed. I will not fail.

Into the lab: Building students' professional identity in STEM

The laboratory is an essential component of STEM education. It is where a student-scientist's innate inquisitiveness might be engaged by working on authentic problems that foster learning through application of the scientific method. These will also break down the artificial compartments that we often use to provide structure to the undergraduate curriculum. I have sought to build the infrastructure for laboratory instruction by seeking grants for the acquisition of high quality instrumentation. As a result, our students gain hands-on experience operating high-field nuclear magnetic resonance spectrometers, electron-spin resonance spectrometers, differential scanning calorimeters and thermal gravimetric analyzers. This provides them with perspectives and skills that optimally prepare them to embark on graduate education or professional training, or to enter the work force.

Throughout my career I have hosted undergraduate students in my research group. This draws students further into the professional practice of science within a hierarchical mentoring environment that involves peers, graduate students and post-docs, as well as the faculty advisor [Wilson, et al., *J. Sci. Educ. Technol.* 2012]. In addition to learning new techniques and concepts, students gain practical knowledge of, for example, laboratory safety, scientific ethics, scientific communication and teamwork. Undergraduate contributions in research have led to co-authorship on papers in top quality journals and on conference presentations. Undergraduate researchers have gone on to complete the doctorate at a variety of top programs, including Ohio State, Texas, Kansas, Michigan, CalTech, Georgia Tech, Cornell, Florida, Colorado State and Harvard. Other students have gone on the medical training at, for example, Georgia Regents' University, Alabama - Birmingham, and Johns Hopkins.

I have maintained a high level of grant support to provide summer research stipends and housing for cohorts of undergraduate visitors from institutions which have a lower level of research activity. The programs often include participants from USG Comprehensive Universities, State Universities and State Colleges. Through these programs, hundreds of visiting students have been placed in a wide variety of research groups. These students have contributed to numerous peer-reviewed papers on which they appear as co-authors. These programs have served as a significant pipeline to the doctorate (ww2.chemistry.gatech.edu/reu).

Broadening participation in STEM research

Our cohorts of summer students are assembled with a keen eye for various dimensions of diversity. Recognizing the small number of minority students who pursue doctoral education in physics, I recently led the development of a multi-institutional REU program which couples Georgia Tech with physics departments at minority-serving institutions in the Atlanta area (www.physicsreu.gatech.edu). The program includes efforts to build partnerships with faculty members at two-year and four-year colleges throughout the state and region. We seek partnerships that will enhance opportunities to support student success and faculty development, with a particular focus on broadening participation in advanced study and research: www.cos.gatech.edu/georgia-tech-undergraduate-math-science-partnerships.

A different type of flipping: Putting professors back in the classroom

Faculty members at four- and two-year institutions face a significant amount of isolation by virtue of the typical size of their departments. They are often the only member of their department's faculty that has a specialization in, for example, organic chemistry, or physical chemistry. In this situation, whether new to the profession or a seasoned instructor, a faculty member lacks a community of practice that best supports innovation and change [Lave and Etienne, *Situated Learning: Legitimate Peripheral Participation*, 1991]. For the last 15 years I have co-directed a national faculty development program to support the adoption of evidence-based active learning pedagogies. This NSF-supported program, *Chemistry Collaborations, Workshops and Communities of Scholars* (www.ccwcs.org), puts professors back in the classroom for week-long workshops in which they learn (or re-learn) materials in new contexts. The workshops model active learning strategies, and support exploration of the five stages of innovation diffusion: awareness, interest, evaluation, trial and adoption [Rogers, *Diffusion of Innovations*, 1983]. The program supports disciplinary communities of faculty members where institutional communities, which might otherwise support curriculum reform, are absent.

INNOVATIVE TEACHING ARTIFACTS

Pre-lecture reading assignments

I began the use of prelecture readings and assignments early in the national discussion of flipped classrooms (i.e., around the time of King's *From Sage on the Stage to Guide on the Side College Teaching*, 1993; and Mazur's *Peer Instruction: A User's Manual Series in Educational Innovation*, 1997). I reported our early results in the *Journal of Chemical Education.* The approach provides structure to student learning and had a significant impact of reducing the number of students receiving "C" and "D" grades.

JOURNAL OF CHEMICAL EDUCATION
Information • Textbooks • Media • Resources

From the Textbook to the Lecture: Improving Prelecture Preparation in Organic Chemistry

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ABSTRACT: The yearlong sequence of introductory organic chemistry lectures was modified to encourage use of the textbook and to engage students to learn material before the lecture. Online prelecture assignments, which we have named HWebs, were used to provide structured motivation for students to read the textbook and begin learning material before they came to class. The HWebs were successful in getting students to prepare for lecture on a regular basis. A survey indicated that students felt positively about being encouraged to prepare for lecture.

In the Laboratory

Our *Journal of Chemical Education* article on the preparation and determination of the structure of a cyclic acetal was a spin-off project from the undergraduate research project of Adolphus Jones. The paper describes an inquiry-based approach in which students perform a chemical reaction and isolate a compound of unknown structure. Determination of the structure by spectroscopic analysis reveals a surprising result that runs counter to what students would expect based on their textbook learning. Students must explain how this product is formed in the reaction. The paper has been cited as an example of an environmentally friendly "green" experiment for undergraduate instruction.

JOURNAL OF CHEMICAL EDUCATION
In the Laboratory

Synthesis and Spectroscopic Analysis of a Cyclic Acetal: A Dehydration Performed in Aqueous Solution

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ABSTRACT: The treatment of aldehydes (and ketones) with diols in the presence of acid gives acetals (and ketals) in an equilibrium reaction. Treatment of pentaerythritol with benzaldehyde in aqueous acid gives the mono-acetal, 5,5-bis(hydroxymethyl)-2-phenyl-1,3-dioxane. The reaction has a number of interesting features. The isolated product is the mono-benzal not the dibenzal, and the reaction, a dehydration, is performed in water… This experiment is suitable for incorporation into the undergraduate organic laboratory as the synthesis of a product for characterization by melting point, solubility, and proton nuclear magnetic resonance. Only through recognition of the three-dimensional structure of the dioxane ring can students explain the appearance of the ^{1}H NMR spectrum of the product. The hydroxymethyl groups of the product are inequivalent, as are the hydrogens of the methylenes in the ring. The experiment may also be presented as a group exercise to optimize the conditions of a reaction to maximize the yield of the desired product.

cCWCS: A national initiative to enhance adoption of evidence-based pedagogies

I co-direct the Chemistry Collaborations, Workshops and Communities of Scholars program (www.ccwcs.org) with colleagues from Georgia State University and Williams College. The program supports STEM education dissemination efforts through the sponsorship of faculty development workshops that promote the adoption of evidence-based active learning pedagogies in chemistry and related disciplines. Over 3,000 faculty members, representing more than 800 institutions from across the U.S. have participated in the program's activities. Participants have used materials from the workshops in a wide variety of ways, including the development of new courses, the redesign of existing courses, implementation of inquiry-based laboratories, and the incorporation of new classroom technologies. To date, cCWCS has engaged 56 faculty members from 18 different USG institutions. In addition, the program has funded a dozen workshops that have been led by USG faculty members and/or held on USG campuses: Professor Anne Gaquere-Parker (West Georgia, *Chemistry of Art*), Julia Metzker (Georgia College, *Using the Climate Debate to Revitalize General Chemistry*), Zhen Huang (Georgia State, *Nucleic Acid Chemistry*), David Sherrill (Georgia Tech, *Computational and Theoretical Chemistry*), Gabor Patonay (Georgia State, *Environmental Chemistry*), John Glushka (University of Georgia, *Nuclear Magnetic Resonance Spectroscopy*) and Seth Marder (Georgia Tech, *Advanced Functional Organic Materials*).

In a recent initiative of the cCWCS program, I have led a group of faculty on the development of the Organic Educational Resources community website (www.organicers.org). The community website has over 300 members who are organic chemistry instructors. They are encouraged to contribute educational materials (exams, experiments, case studies, etc.) to the site for use by others. Annual mini-workshops for 20-30 faculty members provide opportunities to explore new pedagogies and technologies for teaching organic chemistry.

SUPPORT LETTERS FROM STUDENTS AND PROGRAM PARTICIPANTS

Included below are recent comments of faculty members from other institutions that attest to the scope and impact of the NSF-sponsored cCWCS faculty development program which is co-directed by Professor Collard

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Dr. Daphne Norton, Director of General Chemistry Laboratories, Department of Chemistry, University of Georgia

cCWCS workshops provide faculty with hands-on learning experiences. Instructors become students as they explore new laboratory experiments. Faculty members perform experiments and gain the skills and resources to introduce the experiments at their home institutions.

Every semester, more than a thousand students at the University of Georgia construct solar cells that harvest energy from the sun. The cost-effective device that uses a dye-sensitized electrochemical cell allows students to recognize the connection between chemistry principles and modern day applications of science. This experiment was presented at the cCWCS workshop on Materials Science and Nanotechnology at Beloit College.

I have also used materials from the cCWCS workshop on Food science to enrich the Chem1110 introductory course for non-science majors. The course is enhanced through demonstrations and group activities that make a connection between taste and acid components found in various foods.

This fall, the undergraduate laboratories moved into a new Science Learning Center. Our students and teaching assistants appreciate the collaborative learning spaces. The new facilities are designed to facilitate group work. I recognized the value of working at lab tables when attending the cCWCS Chemistry & Art workshop at Millersville University. As a workshop participant, I performed experiments in a laboratory where four scientists worked together at a rounded table. This was a departure from the traditional lab benches from my own undergraduate experience. Long rows of lab benches hinder conversation. I saw how a change in room design could foster collaborative learning. Our new undergraduate laboratories at the University of Georgia have a layout that allows students to gather around an instrument to collect and discuss data. The layout of the room affords more effective sight lines for TAs to ensure safety and monitor how students are performing laboratory techniques. The layout of the room also mimics the arrangement of an actual research laboratory where scientists use modern instrumentation to collect and analyze data.

David is actively involved in the dissemination of course materials through his involvement at the Biennial Conference on Chemical Education. The series of workshops has fostered a community of scholars who share information and develop materials that help students relate the course content to modern advances in science.

My participation in the workshops has impacted the lab curriculum and the pedagogical design of the new facilities at the University of Georgia. Students are engaged by real-world applications and prepared to enter a research laboratory after completion of general chemistry. The cCWCS has influenced the student learning experience and has provided me with a community of scholars who share ideas and have a common goal of student success through critical thinking and problem solving.

CENTRE
COLLEGE

To whom it may concern:

I am writing to provide support for David Collard's nomination for the University System of Georgia Felton Jenkins Jr. Hall of Fame Faculty Award. I have had the pleasure to work with David on chemical education activities that support organic chemistry faculty members throughout the nation.

David Collard has provided leadership and guidance that turned a vague wish for an online community for organic chemistry educators into the thriving organic chemistry education community (OrganicERs, http://organicers.org). Over a lunchtime discussion at a conference, David convinced several of us that face-to-face workshops were necessary for the successful development of a community and suggested cCWCS as a source of support. With David's guidance and financial support from cCWCS, Active Learning in Organic Chemistry (ALOC) workshops have taken place every year since 2013. Each of these workshops has introduced approximately 25 organic chemistry faculty members to pedagogical methods and technological tools to support student-centered teaching methods. The online community now has about 336 members, all of whom are faculty members who teach organic chemistry. Chemical educators are drawn to the website which provides a location for faculty members to share teaching resources such as syllabi, exams, clicker questions, and in-class activities. The website also serves as a place for members to network with peers on discussion boards.

At the most recent Biennial Conference in Organic Chemistry (BCCE), the Active Learning in Organic Chemistry symposium comprised five full sessions. The majority of the symposium's 35 presenters were former ALOC workshop participants, most of whom had not previously attended a BCCE. The symposium was in a large room that was mostly packed for each of the sessions. The spirit of community was evident among the presenters and audience members throughout the sessions that extended through most of the conference.

The cCWCS-supported ALOC workshops have influenced the teaching of organic chemistry students at 90 different institutions. The number is below 100 because several workshop participants have encouraged their departmental colleagues to participate in subsequent years. At some institutions there is a single organic chemistry instructor with no colleagues to consult on a daily basis about pedagogical issues in organic chemistry. Now these individuals are likely reach out to other OrganicERs members via discussion boards or the OrganicERs Facebook group. We are very grateful for the guidance and support David has provided to build the strong foundation for our community.

Sincerely,

Jennifer Muzyka
Stodghill Professor of Chemistry

Professor Lisa Hibbard
Department of Chemistry
Spelman College

I attended the cCWCS "Implementing iPads in the Chemistry Curriculum" Workshop held in Atlanta, GA in May 16-18, 2014. This workshop provided hands-on experience in the use of iPads for various interactive modules that could be used in the chemistry curriculum. I was interested in attending this workshop as I had recently been awarded an NSF Targeted Infusion Grant that had as one of its primary aims the revision of the General Chemistry course sequence at Spelman to incorporate a blended learning format. This grant supported the purchase of iPads for use by students in the course sequence. Since attending this workshop, the general chemistry sequence has been revised to incorporate a number of iPad-based activities, including the use of simulations published through the University of Colorado's online PhET site (e.g., acid-base solutions, build an atom, gas properties, concentration, models of the hydrogen atom, molarity, salts and solubility) and the use of apps such as iSpartan, VSEPR, and Atoms in Motion. Several of the PhET simulation activities were integrated into POGIL worksheets used by student teams during in-class active learning sessions. Assessment of student learning gains on related questions (*N*=6) on the ACS standardized cumulative final exam for AY2015-16 showed a score increase over those of students who did not use the simulations the prior academic year. The use of iPads in this course sequence was described in my recent publication:

L. Hibbard, S. Sung, and B. Wells, "Examining the Effectiveness of a Semi-Self-Paced Flipped Learning Format in a College General Chemistry Sequence," *Journal of Chemical Education* **2016**, *93*, 24-30.

The following letters and excerpts have been received in the past by the School of Chemistry and Biochemistry in relation to previous award nominations. They attest to Dr. Collard's effectiveness in teaching over a 25-year period.

Outstanding Use of Educational Technology Award

Anjli Kumar, Chemistry major (currently in Ph.D. program, University of Texas)

I am a third year chemistry student at Georgia Tech and I can confidently say that Dr. Collard is the reason that I chose to keep chemistry as my major. During my second year at the Institute, I registered for Dr. Collard's section of organic chemistry. I had heard rumors about how this course was one of the more challenging chemistry courses that I would encounter while obtaining my bachelors. I braced myself for a difficult semester.

As the semester progressed, I enjoyed the course more and more. Dr. Collard had an interesting approach in teaching the material - he wanted to monitor our progress at every step of the way. He accomplished this using a couple of technological features: HWebs on WebCT and PRS questions in class. HWebs are a three-question quiz based on that night's reading assignment. This was a very clever method to ensure that students stay up to date with the reading and is probably the primary reason that I learned so much in Dr. Collard's course. PRS questions were equally important in monitoring our progress throughout the course. Because these questions were asked spontaneously throughout the lecture, they would keep the students on their toes. It forced us to not only write down everything Dr. Collard wrote down; this technique forced us to understand what Dr. Collard was teaching us. I wish that all teachers would use these advancements of technology to ensure that the students are actually following along.

As I continue to take courses in chemistry, I realize a valuable skill that I learned in Dr. Collard's course. He required the use of ChemDraw on all homework assignments. At the time, ChemDraw seemed to be an obnoxious tool that could be bypassed by completing homework by hand. However, now that I am a senior in chemistry, I realize the importance of this software goes a lot further than homework assignments. I have used ChemDraw in many chemistry classes, labs, and as a tool in undergraduate research. It would have been a lot more difficult to complete those assignments satisfactorily had Dr. Collard not made it such a strict requirement in his course.

These technological tools contributed a lot to the overall organization of the course. It forced us as students to stay fresh with the material and it also taught us useful tools to be used in the future.

Whitney Komorner, Biology major; Stone Mountain, Georgia

I have taken many classes at the Georgia Institute for Technology. In many of my classes students are required to have a basic knowledge of technology in order to succeed, but rarely is this learning facilitated by the professor. In taking Organic Chemistry I with Dr. David M. Collard, the use of technology was not only prevalent, but taught as part of the course.

Dr. Collard required the use of several technological advances, all of which he taught us how to use. The regular use of these methods allowed the students to become fluent in programs such as ChemDraw and Chem3D, which we would otherwise have had no exposure to. The Personal Response System (PRS) was used often if not every day in the class room. This transmitter allowed the entire class to submit personalized answers to questions asked in class, and was a great help in learning the material.

The use of websites, specifically WebCT, is also prevalent in Dr. Collard's teaching methods. In previous classes we were required to submit multiple choice answers to online homework problems called HWebs using WebCT. While we were also required to submit written homework assignments, these tasks primarily used the ChemDraw program as the medium of work.

By the end of the semester, students were proficient in using both ChemDraw and Chem3D as part of their chemistry work, a skill from which I have greatly benefited since going on to do research in organic chemistry. I can honestly say that Dr. Collard's teachings in the field of technology have been a great advantage in current studies. These teachings have and will continue to impact future endeavors.

Outstanding Teacher Award:

Scott McKee, Chemistry major (went on to compete M.D. at Medical College of Georgia) [excerpt]

It is truly rare that you find a professor that possesses the dedication to students that Dr. Collard has. Never in my educational experience have I encountered someone that so consistently puts students first. He provided me and many others with the opportunity to think independently, to be challenged, and to delve deeper into our personal scientific interests. He allowed me to build confidence in myself as a scientist by having confidence in me. He served as my teacher, advisor, mentor, and friend throughout my career at Tech. Without a doubt, Dr. Collard is the most influential teacher I have ever had.

D. Allen Annis, Chemistry major (went on to complete Ph.D. Harvard University) [excerpt]

My academic experiences with Prof. Collard during my years at Georgia Tech were all exceptionally positive. In the classroom Prof. Collard was a great motivator. His lectures were always well planned, entertaining, and full of concrete examples for what was often abstract material. His sincere devotion to teaching and genuine dedication to his students made his classes, especially his introductory polymer chemistry course, very popular among students in the Chemistry and Chemical Engineering curricula. Prof. Collard was always willing to pause and review more difficult points, and was especially generous with additional study sessions and extra office hours.

In the laboratory, Prof. Collard encouraged his students by setting a positive example as an enthusiastic researcher and scientist. His excitement for teaching in the lab as well as in the classroom was evidenced by his dedication to improving the undergraduate teaching labs. In collaboration with Prof. Lawrence Bottomley, Prof. Collard and I co-authored a paper in the Journal of Chemical Education describing several new experiments for the organic and analytical chemistry labs. (J. Chem. Ed. 1995, 72, 460-462).

Perhaps the most memorable way in which I was influenced by Prof. Collard does not relate to his role as a classroom teacher or a laboratory supervisor, but rather as a dedicated advisor and friend. Prof. Collard is among the few faculty members I know whose door is always open to students for open dialogue about any school-related and even non school-related subjects. On many occasions I utilized Prof. Collard's accessibility to discuss my potential future as a chemist, and for this I attribute to him much of the credit for my current level of success. Mine is not, however, a unique case; I know many other students who shared similar experiences with Prof. Collard, and I am confident there will be more.

The following comments are taken from anonymous course evaluations

Professor Collard seemed to really care about the students learning the material. He taught well, considering the difficulty of the material.

Material in this class was presented clearly and effectively. Class lectures were valuable and review sessions were helpful.

I feel confident that I gained the tools in this class to do well in other organic chemistry classes.

Excellent teaching style. I always loved coming to class

By far one of my favorite proffessors at Tech.

I am pleased with the way the course progressed. I was especially pleased by the professor who managed to hold my attention for the entire period, which I find is usually hard to do.

DR. COLLARD'S CLASS WAS VERY ENJOYABLE. IT WAS A PLEASANT CHANGE TO SEE A PROF. THAT ACTUALLY SEEMED TO CARE ABOUT HIS STUDENTS

DR COLLARD IS ONE OF THE BEST LECTURERS I HAVE SEEN. HE EXHIBITS A NATURAL TALENT FOR TEACHING; HE IS ABLE TO EXPLAIN TOPICS CLEARLY AND CONCISELY.