

**WSCUC THEMATIC PATHWAY TO
RE-AFFIRMATION OF ACCREDITATION
INSTITUTIONAL REPORT**

SUBMITTED AUGUST 2020

Caltech

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Our report follows WSCUC’s instructions for institutions participating in the Thematic Pathway for Review (TPR) and addresses the required four components (1, 2, 8 and 9). Component 1 briefly introduces Caltech, highlights major changes since the last accreditation review, and responds to the 2010 Commission letter. Component 2 demonstrates Caltech’s Compliance with WSCUC Standards and Federal Requirements Worksheet and Forms, and summarizes our assessment and program activities in the Inventory of Educational Effectiveness Indicators (IEEI). Component 8 explains the process and the evidence-based approach used to determine the two TPR themes: the **Core Curriculum** and **Academic and Co-Curricular Support Structures**. This component refers to a “Key Findings” document that accompanies the report. Within these components, relevant CFRs are noted in bold. Component 9 discusses the impact of our self-study and next steps.

COMPONENT 1: INTRODUCTION

On October 24, 2014, Caltech President Thomas F. Rosenbaum gave his inaugural address and described the elements that characterize Caltech: Excellence, Ambition, Focus, Intimacy, and Perspective. “Each of these elements,” he said, “is by itself difficult to achieve, and perhaps even more challenging to maintain in changing times, but taken together they yield intellectual magic.” Sustaining the intellectual magic that defines Caltech drives every member of the Institute, including staff, students, postdocs, faculty, and administrators. Our efforts, whether geared towards research or teaching, towards Mars or classrooms on Earth, strive to prepare students “to tackle any challenge with quantitative skills, but even more importantly, to use those skills to define new directions through distillation of the underlying principles” (Thomas F. Rosenbaum, 2018 Commencement Address).

This report illustrates Caltech’s profound commitment, in the words of the July 8, 2010 Commission letter to then President Chameau, to “provid[e] an extraordinary educational

experience for its students and . . . to both continue and enhance that practice.” These goals are written into Caltech’s mission statement: “The mission of the California Institute of Technology is to expand human knowledge and benefit society through research integrated with education. We investigate the most challenging fundamental problems in science and technology in a singularly collegial, interdisciplinary atmosphere, while educating outstanding students to become creative members of society.”

The accreditation process gives Caltech the opportunity to demonstrate our ongoing dedication to continuing and enhancing the extraordinary education that is the hallmark of the Caltech experience. Our students deserve nothing less. With an admission rate of 6.4%, Caltech is one of the most selective four-year institutions in the world. Of the approximately 250 students in the entering class, 99% place in the top tenth of their high school graduating class. The typical first-year student scores between 790-800 on the math portion of the SAT, and between 740-780 on the reading and writing portion. Those taking the ACT score between 35 and 36. A perfect score on the SAT Math Level 2 subject test is the median. Scores on subject tests in physics, chemistry, and biology range from 760 to 800.

We are proud of what we have accomplished since 2010, and also realize that institutions can and must always improve, whether that means innovating the curriculum in light of technological and scientific advances or buttressing support structures to meet student needs. The work we have done since the last accreditation – a commitment to assessment; a consensus around learning outcomes; an investment in support structures, to name just a few of the steps we have taken -- has prepared us for the tremendous challenges of 2020. Caltech has unhesitatingly come together during the COVID-19 pandemic. The decisions made by the leadership have been done in the way that we make all decisions: thoughtfully and decisively, with input from students, faculty, and staff, and in the community’s best interests.

Institutional Context

Before Caltech became Caltech on February 10, 1920, it was the Throop Institute, founded in 1891. What began as a college with six faculty and about thirty students is now a scientific institute with over 300 faculty, approximately 1000 undergraduates, 1300 graduate students, and 600 postdoctoral scholars. Throop Institute was one building; Caltech is a 124-acre campus. This does not include Caltech's off-site facilities, such as the Jet Propulsion Laboratory (JPL), the Palomar Observatory, the W.M. Keck Observatory, and the Laser Interferometer Gravitational-Wave Observatory (LIGO), which on September 14, 2015 directly observed gravitational waves. This discovery led to a 2017 Nobel Prize in physics for Caltech's Barry C. Barish, the Ronald and Maxine Linde Professor of Physics, Emeritus, and Kip S. Thorne, the Richard P. Feynman Professor of Theoretical Physics, Emeritus, and Rainer Weiss, Emeritus Professor of Physics at MIT. In 2018, Frances Arnold, the Linus Pauling Professor of Chemical Engineering, Bioengineering, and Biochemistry received the Nobel Prize in Chemistry.

This TPR process gives us an opportunity to demonstrate our commitment to a culture of excellence in teaching and learning that equals our pursuit of research excellence. Since the 2010 accreditation, Caltech has undergone significant transformation in improving our educational mission. In 2011, a summer online course called Math 0 was developed to prepare students for Caltech's proof-based Math 1a class. The Center for Teaching, Learning and Outreach (CTLO) was founded in 2012. 2012 also saw the reorganization of the Hixon Writing Center (HWC) and the appointment of a new director, an expansion of its staff, and an integration of its expertise across the Institute. In 2013, the Biology division became the Biology and Biological Engineering (BBE) division. 2013 was also the first year that Caltech, along with UC Berkeley, Stanford, and UCLA, received an NSF grant for the Alliance for Graduate Education and the Professoriate (AGEP), [a postdoctoral program intended to increase the number of URMs in tenure-track positions](#). Revisions to the Core were implemented in 2014. The Caltech Center for Inclusion and Diversity

(CCID) was reorganized in 2014, and in 2015 moved from Student Affairs into the Provost's organization. That same year, President Rosenbaum appointed Caltech's first Chief Diversity Officer, and the first Senior Director for Diversity was hired. These appointments led to a reorganization and expansion of the CCID. Also, in 2015, Caltech inaugurated its annual TeachWeek, an event organized by the Center for Teaching, Learning, and Outreach (CTLO), showcasing faculty's creative teaching and guest speakers with pedagogical expertise. In 2016, the President's Diversity Council membership changed to focus more on faculty diversity. Each of the six divisions is now represented, along with two division chairs who rotate bi-annually. In 2017, Andrew and Peggy Cherng endowed the Andrew and Peggy Cherng Department of Medical Engineering in the division of Engineering and Applied Science (EAS), with the goal of "enabl[ing] new discoveries and cures, rippling out to improve human lives everywhere." 2017 was also the year that Caltech received an Association of American Universities (AAU) mini-grant for its Inclusive Caltech Core (IC²) initiative to improve STEM pedagogy in introductory classes. In 2018, Caltech hired a new Chief Institutional Research Officer who reorganized and enhanced our approach to assessment. In 2019, the Career Development Center (CDC) was restructured and a new director appointed. An executive director of Student Wellness Services (SWS) was appointed in 2019, with an expansion of staff and responsibility.

Other big changes have occurred. Caltech is more diverse. Women in 2010 represented 39.5% of the undergraduate student body and now they represent 45.3% of the student body. In 2010, underrepresented minority students were 8.4% of the undergraduate population. Today, that figure stands at 19.0%. The progress that has been made over the past decade has resulted from significant investment in and expansion of efforts to make Caltech more inclusive. Efforts include, but are not limited to, the recruitment of a diverse student population by the Undergraduate Admissions office, the reorganization of the Freshman Summer Research Institute (FSRI), and the expansion of summer research opportunities in Student-Faculty Programs (SFP)

designed to create a diverse pipeline for graduate programs. We understand there is more work to do on inclusion and diversity. The Data Appendix will include diversity statistics broken out by race, ethnicity, and gender, as well as retention and graduation rates. As part of our ongoing efforts to improve Caltech's representation of underrepresented populations, we will be conducting a campus-wide climate survey, expanding our postdoc diversity fellowship initiative, and developing an incoming Graduate Student Research Institute to foster cohort building among our underrepresented students in the graduate school.

The campus's built environment in 2010 has also changed. The Sherman Fairchild Library (SFL) features a Tech Lab, created in 2015, where students can indulge their creativity through 3D printing and a virtual reality workstation. In 2016, the undergraduate Electrical Engineering (EE) labs were renovated with support from the Provost's Innovation in Education Fund and the division of Engineering and Applied Science (EAS). The Bechtel residence opened in 2018 and houses almost 25% of undergraduates, making it possible for virtually all undergraduates to live on campus. The Student-Faculty Programs office moved in 2018 from a 618 square foot office to a refurbished house with 1375 square feet, accommodating an expanded SFP staff that in 2010 worked with 706 students and now enables 926 students to do research alongside graduate students, postdocs, and faculty. The Hameetman Student Center, dedicated in 2019, is a vibrant hub for intellectual exchange and social activities. The Tianqiao and Chrissy Chen Institute for Neuroscience, a 150,000 square foot facility, will open in 2020. The Resnick Resource Center, dedicated to research and education in sustainability, funded by the transformational gift of Lynda and Stuart Resnick, will soon begin construction.

These changes, and the investments they represent, capture Caltech's evolution and priorities since 2010. The Institute's resources and time have focused on improving the student experience both in and out of the classroom. Our approach has been evidence-based and developed and embraced by the community-at-large. Because Caltech is small, the most

important institutional processes can engage the entire community in a widespread and comprehensive fashion. This method has guided us through the TPR.

Response to the 2010 WSCUC Commission Letter

For the 2010 accreditation cycle, Caltech examined the Core Curriculum, the Honor Code, and Undergraduate Research, and the Commission acted to “reaffirm the accreditation of the California Institute of Technology” for ten years. Revisiting the IEEI for the 2015 mid-cycle review was an opportunity for self-reflection that led to heightened clarity and transparency in how academic programs communicated learning outcomes to the Caltech community. In 2017, Caltech was notified of its eligibility to apply to participate in the TPR, and our request was approved. In 2018, the Accreditation Steering Committee (ASC) was constituted for the purpose of developing our themes. Focus groups across campus were organized and helped choose themes that would “establish a framework for connecting our institution’s context and priorities with the Core Commitments and the Standards of Accreditation.” **The Core Curriculum and Academic and Co-Curricular Support Structures** were the themes we selected based on the 2010 Commission letter and the directive to tie themes “explicitly to the Standards and relevant CFRs.” That letter noted areas where the institution was doing well and also identified areas that needed further attention and development. This section of the 2020 Institutional Report delineates the progress Caltech has made in addressing the CFRs specifically identified in the Commission letter (**CFRs 1.2, 2.2-2.4, 2.6-2.9, 4.4-4.6**), and refers to others for additional information.

The Core Curriculum (CFRs 1.2, 2.2)

Caltech’s Core Curriculum is the signature undergraduate academic experience. The catalog states: “A Caltech education requires not just the depth of an option, but also considerable breadth in basic science, humanities, and social science. Caltech’s Core Curriculum prepares

students for the interdisciplinary nature of contemporary research in science and technology. This encourages a culture of problem solving, collaboration, and communication while providing valuable experience in all fields of science. Significant study in the Humanities and Social Sciences is an important component of Caltech's Core Curriculum, giving alumni the ability to navigate the societal, political, and economic factors that influence, and are influenced by, their work" (233). Because the Core is so crucial, responsibility for it is distributed throughout the Institute. Divisions determine the content and quality of their Core classes, while institute committees oversee the content and quality of the Core in its entirety. Balancing these approaches can be challenging; however, this distribution of oversight and assessment is in keeping with Caltech's organizational structure, which tacks between giving divisions independence to teach the Core in the way they think is most effective while providing the proper degree of oversight to ensure that the Core classes are in alignment with respect to teaching quality and content.

Students must complete the following requirements in order to graduate: Freshman Mathematics; Freshman Physics; Freshman Chemistry; Freshman Biology; a Menu Class, where students select one from the following introductory classes in Astronomy, Electrical Engineering (EE), Environmental Science and Engineering (ESE), Geology, or Information and Data Sciences (IDS); a Freshman Chemistry Laboratory; an additional Introductory laboratory; Scientific Writing; 4 Humanities (2 introductory; 2 advanced); 4 Social Sciences (2 introductory; 2 advanced); 4 additional courses in the Humanities and Social Sciences (HSS); Physical Education.

The content of the Core has changed since 2010 and will surely continue to change as it keeps pace with advances in science and technology, and as we assess its effectiveness with respect to achieving our shared learning outcomes. The process by which modifications to the Core have been made, the nature of those modifications, and Caltech's assessment of them, will be discussed below. The deliberative process by which the Institute has reconsidered and refined its shared learning outcomes, and how they have been used to assess the Core, will also be

explained. As the Commission recommended, we have striven to “address the need for a coherent voice that articulates the Core Curriculum rationale to the larger Caltech community in order to foster support for the Core and its alignment with Caltech’s mission” (CFR 2.2).

Students, and the Institute as a whole, have a great sense of accomplishment as they work their way through the Core. A 1986 Report on the Core states, “Caltech takes considerable pride in graduating biologists who understand the laws of quantum physics and can apply them to molecular biology, neurobiology or biophysics; surface and materials scientists who can design new processes and materials based on modern chemical principles and physical concepts; and electrical engineers and computer scientists who can invent new logic circuits, or develop computer software founded on modern preparedness as it relates to the Core.” Professor John Dabiri, former Undergraduate Dean and Faculty Board Chair, “noted that [students] take pride in the difficulty of the curriculum” and “urged that students be reassured that these changes [to the Core] will not make the Caltech education any less ‘rigorous.’” Even college websites, such as *Admissionado* observe: “Caltech’s high-achieving cohort of students and comprehensive Core Curriculum make for a reputedly, you guessed it, intense academic experience” (2018). The intensity, interdisciplinarity, breadth, and depth are features of the Core that will remain constitutive of the Caltech experience, even as its content evolves. Because the Core is the common denominator of the Caltech experience, the Institute proactively assesses it on an ongoing basis to determine its effectiveness during the time students are completing it, as well as its implications for students’ progress once they have completed the Core. Below is a brief account of evaluations of and adjustments to the Core from 1986 to 2020.

The appointment of an Ad Hoc Committee on the Core set the stage for its first serious reconsideration in 1986. This committee suggested changes that would increase the breadth of undergraduate education and provide students with more time to satisfy their “intellectual curiosity.” [Recommendations](#) included lowering the number of units required to graduate from 516

to 480; reducing the 9-unit additional laboratory requirement to 6 units; dropping the 6-unit computing requirement; and reducing the number of courses taken per term by first-year students from 5 to 4.

The Core was also changed to increase the breadth of science education. Physics and Math each reduced the number of classes from 6 to 5. The Chemistry requirement decreased the number of classes from three 6-unit classes and one laboratory class to two 9-unit classes and one laboratory class. These modifications made room for a Biology class, a Menu class either in Astronomy or Earth and Environment, which increased the breadth of the Core, and a 3-unit Scientific Writing course. The 1996 Ad Hoc Core Curriculum Committee explained: “The new biology and menu classes are primarily intended to expose students to important aspects of science that are currently not part of their Core. They can be secondarily helpful for some students to decide on their major.” The visiting committee applauded these revisions and called them a “milestone achievement that has come after the careful deliberation characteristic of Caltech” that “resulted in major changes reflecting [its] missions and goals.”

The Core has undergone significant revision since 2010. Under the direction of President Chameau, the Institute established several Ad hoc committees to conduct self-studies. These included the [2007 Student Experience Report Committee](#), the [2008 Aims and Needs Committee](#), and the [2008 Core Curriculum Task Force \(CCTF\)](#). The CCTF considered revisions to the Core, specifically reducing the number of requirements to make it easier for students to pursue their academic passions earlier in their Caltech career. These changes would allow students to enroll, as early as their sophomore year, in smaller advanced-level classes with more one-on-one interactions with faculty, more opportunities to do research, and greater flexibility in course schedules. Working alongside the CCTF was the [Caltech Mental Health Task Force](#), which reported to the Board of Trustees and President Chameau, and communicated regularly with the Caltech community, including alumni. This task force was a response to three student suicides in

2009-10. Recommendations included strengthening the resident associate infrastructure, expanding the counseling center staff, and reducing stress for undergraduates. The mental health benefits of implementing these revisions were of paramount importance in future deliberations. We have continued focusing our attention on students' mental health and expanded our services in this area to meet increased need. This issue will be further addressed in the Student Wellness Services in-depth assessment.

The proposals outlined by the Task Forces went through an iterative process led by then Vice Provost Melany Hunt. The Faculty Board approved the revisions, which were implemented in 2014. Other changes included giving first-year students shadow grades (the letter grades they would have received) in the fall and winter terms when classes are taken Pass/Fail; enhancing writing instruction by requiring that 3 out of a student's 12 Humanities and Social Science (HSS) classes be writing-intensive (p. 234, Catalog); and creating the Center for Teaching, Learning, and Outreach.

The work of the Core Curriculum Task Force (CCTF) led to the 2014 revisions to the Core, and was also instrumental during this 2020 accreditation cycle. In 2010, they recommended:

- Formulating the learning outcomes associated with the Core Curriculum and determining whether these outcomes should be the same for every Caltech student;
- Ensuring that the curriculum will support the learning outcomes;
- Defining mechanisms to assess the level of student achievement and the quality of the student experience;
- Finding ways that research and/or independent activities can be brought into the Core Curriculum, especially at the earliest stages;
- Making changes or enhancements to strengthen the Core Curriculum experience, such as technology in the classroom, increased student-faculty interactions, or variations in the pass-fail grading system.

These recommendations have been addressed, with the goal of ensuring that “educational objectives are widely recognized throughout the institution, are consistent with stated purposes, and demonstrably achieved” (CFR 1.2). The appendices present institutional data that has been collected and assessed post-implementation. Furthermore, we have made clear and publicly available, “the coherent philosophy” of Caltech, how it is “expressive of its mission,” and how that philosophy “guides the meaning of its degrees and processes,” thereby “ensuring the quality and integrity of its degrees” (CFR 2.2). The following interventions have taken place since 2010:

- The Core learning outcomes have been updated, broken out into components for the purposes of direct and indirect assessment, and discussed and endorsed by the Core Curriculum Working Group (CCWG), the six academic divisions, the Accreditation Steering Committee (ASC), the Faculty Board, the Institute Academic Council (IACC), the Board of Trustees, the Core Curriculum Steering Committee, and the Committee for Undergraduate Education. (CFR 2.4)
- The Core learning outcomes are posted on the following websites: the six academic divisions; [Accreditation](#); [Caltech Center for Inclusion and Diversity](#); the [Center for Teaching, Learning, and Outreach](#); [Undergraduate Admissions](#); [Undergraduate Deans' Office](#); [Student-Faculty Programs](#); the [Committee for Undergraduate Education](#); the Officers of the Faculty, and the [Library](#). (CFR 2.3)
- Curricular revisions that support the learning outcomes are ongoing and take place at the Institute level and in division/option curriculum committees.
- Mechanisms to assess student achievement and the quality of student experience occur through the Teaching Quality Feedback Report, Student-Faculty Conference, Academics and Research Committee, committees within divisions, [Inclusive Caltech Core](#), mid-quarter survey feedback, and ombudspersons.

- Research and/or independent activities have been integrated into the Core through the Menu course requirement, freshman seminars, and frontier or “pizza” classes, which are one-unit courses designed to introduce students to a field of study (for example, Bioengineering 1, p. 499 Catalog).
- Enhancements to strengthen the Core experience include technology in the classroom (flipped classrooms, learning management systems, clickers, and GradeScope, a tool that allows faculty to give students feedback on exams and problem sets), expanding the peer tutoring network, adding resources to the Hixon Writing Center, and increasing access to the Freshman Summer Research Institute (FSRI).

In addition to these significant enhancements, we believe that the faculty understanding of the Core is stronger as a result of the work of the various task forces and the CCWG. A theme that runs through all of the evaluations of the Core is a tension between wanting to give students as much flexibility as possible while adhering to a Core that ensures that students achieve our learning outcomes. We believe that this tension is ultimately productive in that our assumptions about the Core need to be reevaluated on an ongoing basis. Given this reality, we will continue this process of community-building with respect to the Core by making permanent the Accreditation Steering Committee, whose members are well-positioned to ensure that assessment of the Core and the faculty participation that is vital to it are sustained.

Undergraduate Research (CFRs 2.2, 2.3, 2.4, 2.6, 2.8, 2.9)

The 2010 Commission letter notes, “the undergraduate research program at Caltech garners strong endorsements from students and alumni and, appropriately, is being protected in difficult budget times.” Three recommendations were made regarding undergraduate research: 1) “ensuring that all undergraduates desiring to do so can participate in a research experience”; 2)

strategies making it easier for students to match with an appropriate research mentor; **3**) and more formalization of the assessment of undergraduate research.

In 2015, the Curriculum Committee engaged in a robust discussion of undergraduate research and determined that adding another Core requirement in the form of a research experience was unwise, especially given the recent (and successful) effort to reduce the Core requirements. Although undergraduate research was a *desideratum*, the best approach would be to facilitate a research experience for those students who wanted one. This was also one of the goals of the 2017 four-year student experience committee. This committee redefined a Caltech education as a four-year experience designed to optimize student learning and to improve student well-being by creating time in their schedules to do research and to participate in more extra-curricular activities. The number of courses per quarter was adjusted so that the distribution of work over the four years was more balanced. In responding to the Commission recommendation about enhancing research opportunities, the 2017 committee considered “the meaning” of a Caltech degree and processes that ensure the quality and integrity of its degrees (**CFR 2.2**); stated the value that Caltech places on “research, scholarship, and creative activity” by changing the number of units per quarter that students are permitted to take (**CFR 2.8**), and recognized and promoted the symbiosis between scholarship conducted by undergraduates and their learning.

Throughout their deliberations, the four-year student experience committee was guided by issues raised by the WSCUC team. Caltech’s mission and educational outcomes provided focus for the committee’s deliberations. Evidence-based data, initially provided by the Faculty Board and supplemented by the Financial Aid Office and the Registrar, helped committee members “take collective responsibility” for establishing “appropriate standards of performance” throughout a student’s four years at Caltech (**CFR 2.4**). Expectations for student performance regarding undergraduate research are explicitly stated on the Student-Faculty Programs website. The Summer Undergraduate Research Fellowship (SURF) program is one of our premier out-of-class

learning experiences, and as such is aligned with the standards of performance in the wider, Caltech learning environment (CFR 2.3). Through a rigorous assessment process, SURF “challenges students to meet high standards of performance. . . and provide(s) them with ongoing feedback about their performance and how it can be improved” (CFR 2.5). Faculty evaluate the students, and students evaluate faculty. Students also evaluate their own progress over the course of their summer research experience.

Commission Recommendation 1: Ensuring that all undergraduates desiring to do so can participate in a research experience. “Engaging students in meaningful learning through research” is one of the academic and co-curricular support structures objectives. Supporting and facilitating undergraduates in their research pursuits has been an Institute priority since 2010 and well before. Since 2010, student participation in Student-Faculty Programs has grown by 32%. An influx of non-Caltech students explains much of this increase, which benefits our Caltech students by exposing them to students from other schools. That said, the percentage of Caltech students participating in SURF remains at a steady 90%. To maintain this level of participation, several approaches were deployed. The four-year student experience committee reviewed data that showed an increase in students graduating early by completing coursework and not taking advantage of research opportunities. The committee encouraged student engagement in research by defining a Caltech education as a four-year experience and backing that up by a redesign of the number of units students could take in any given quarter. We expanded the number of undergraduate research opportunities available to Caltech (and non-Caltech) students, including an exchange with the Indian Institute of Gandhinagar in 2011 and WAVE in 2015. We also increased the stipend for summer research in 2017, and it is now annually adjusted to offset cost of living increases. We do not want students to decline a meaningful research experience because of funding issues. These programs generate a range of student projects from “The Role of

MicroRNAs in Modulating HIV Infection” to “Analysis of Vote Share Drifts During Post-Election Canvass in Orange County.”

Commission Recommendation 2: Strategies making it easier for students to match with an appropriate research mentor. An objective of the Academic and Co-curricular support structures is “**Providing access to mentors and mentoring.**” Student-Faculty Programs (SFP) encourages students to contact the office and/or go to the SFP website where potential mentors list research opportunities. For the Summer Undergraduate Research Fellowship (SURF), locating a mentor is an aspect of the learning process itself. Students “attend seminar classes and option seminars where faculty present their work” and “look outside their academic option because research at Caltech and JPL is very interdisciplinary.” These recommendations dovetail with several Core Curriculum learning outcomes; for example, students will be able to “**develop and satisfy their intellectual curiosity**” and to “**apply their knowledge and skills to diverse problems within and across disciplines.**” SFP supplements this advice by meeting individually with students in order to facilitate a match with potential mentors.

Caltech’s WAVE summer undergraduate research program works differently with respect to mentorship. SFP matches students with mentors. WAVE is for non-Caltech undergraduates, and is designed to increase diversity by bringing to campus highly qualified women, underrepresented minority students, and students with disabilities who may be candidates to pursue a Caltech graduate degree. WAVE fellows must have a cumulative GPA of at least 3.2/4.0, which is higher than for SURF. As a further inducement to do research at Caltech, WAVE covers the cost of housing and transportation. WAVE contributes to the goal of “**cultivating an inclusive learning environment,**” an academic and co-curricular support structure objective.

The importance of mentoring, documented in evidence-based research, is acknowledged campus-wide, and offices have taken concrete steps to facilitate the student-mentor connection. The Caltech Center for Inclusion and Diversity (CCID) coordinates, with campus-wide assistance,

the Freshman Summer Research Institute (FSRI), a five-week cohort-building program for incoming students who may be at a disadvantage because they are unfamiliar with proof-based math and/or unacquainted with the research process. FSRI, like WAVE and SURF, overlaps with objectives of the Support Structures Working Group (SSWG) including “**building community and fostering students’ sense of belonging,**” and “**cultivating an inclusive learning environment.**” A crucial aspect of FSRI, like WAVE and SURF, is the student-mentor connection, which the CCID puts into place. The CCID also prioritizes mentorship in the Mellon-Mays Undergraduate Fellows (MMUF) program where a requirement is participating in undergraduate research with a faculty mentor, and in Women Mentoring Women (WMW). The CCID in-depth assessment provides data on the success of these programs, including the following: Caltech’s through-put rate for Mellon-Mays Fellows is the highest among participating schools, and we are the [only institution now allowed to use this funding for students pursuing Ph.D.s in STEM](#) (all other schools are restricted to funding students in the humanities and social sciences); the expansion of WMW, which in 2010 had 94 participants and over the years has reached 183 participants; and Caltech’s AGEP program, which had more underrepresented minority postdocs in its AGEP cohort than the other three universities combined.

The mentorship aspect of undergraduate research has changed since 2010. In 2016, SFP developed an annual Caltech Conference on Mentoring Undergraduate Researchers. SFP and CTLO also hosted a series of workshops on effective undergraduate research mentoring practices that were geared towards graduate students, postdoctoral students, and other community members. Campus-wide interest for effective mentoring led Caltech to establish a “Certificate of Interest in Undergraduate Mentoring.” These efforts reflect the importance of “**Improving instruction quality and teaching practices,**” a SSWG objective (CFR 2.9).

Commission Recommendation 3: More formalization of the assessment of undergraduate research. SFP has developed a set of shared rubrics for assessing the

undergraduate research experience. The rubrics are aligned with the learning outcomes which state that students will be able to: 1) develop a research question, problem, or design; 2) apply basic principles and knowledge found in the literature related to the research question; 3) develop a research proposal to address or resolve a specific research question or problem; 4) apply and evaluate methodology throughout the project; 5) collect, interpret, and critique data in order to resolve a research question or evaluate a design; 6) communicate research findings; and 7) appreciate what the process of scientific research entails.

All students assess themselves at the beginning and end of their SURF, and faculty assess students in two interim reports during that time. At the start of the summer, students indicate their current level of proficiency, knowledge, and/or experience in the following areas: 1) developing a research question, problem, or design; 2) conducting a literature review; 3) applying scientific theories; testing scientific hypothesis; collecting data; analyzing data; 4) understanding research techniques in one's field; 5) communicating research findings through oral presentations; 6) communicating research findings through poster presentations; and 7) communicating research findings through scientific writing. This self-assessment aligns with the **five Core Competencies**, Caltech's mission, its institutional aspirations, and several Core Curriculum learning outcomes. We believe that the Student-Faculty Program's emphasis on oral and written communication is especially important given data indicating that there is room to improve our effectiveness with respect to these particular Core Competencies (See [Core Curriculum Working Group Report](#), pp. 35-46; see also [Data Appendix](#), Figures D-1 & D-6).

Seminar Day also gives students the opportunity to present their research, and a feedback sheet is provided to assess and improve students' communication skills. During Seminar Day, students are invited to present their work in the Perpall speaking competition. SFP provides rating criteria and judging sheets. The Gee and Vodopia poster competitions also have [rating criteria and judging sheets](#) (CFR 2.6). These innovations to the undergraduate research experience have

enhanced the SURF experience and have given the program increased visibility and prestige. The fact that 80% of SURF projects are being done remotely during the COVID-19 crisis illustrates the faculty, student, and administration's commitment to undergraduate research. Several faculty completely reimaged the original SURF project in order to make it possible for students to conduct research remotely during summer 2020.

Assessment of Student Learning (CFRs 2.3, 2.4, 2.6, 2.7, 4.4-4.6)

Caltech has made significant strides in its assessment of student learning, beginning with the creation in August 2012 of the Center for Teaching, Learning, and Outreach (CTLO), which helped establish a more integrated institutional framework for addressing several of the Commission's recommendations. For example, faculty are aware of and increasingly committed to making sure that "student learning outcomes are reflected in course syllabi" (CFR 2.4). We have seen progress in this regard, but the level of detail in syllabi remains uneven, with some being very complete about learning outcomes and assessment and others less so. In division meetings with the Accreditation Liaison Officer (ALO) and through CTLO activities, faculty have been encouraged to make clear to students in their syllabi what they should learn in their classes, and how that learning will be assessed. At the start of the 2014 academic year, Caltech responded to the team's concern that "specific learning outcomes of the various academic programs . . . were not consistently presented." The mid-cycle review gave us an opportunity to revisit our IEEI, which led to a successful effort to make evident the learning outcomes associated with each option. This campus-wide commitment to transparency worked to ensure that "the institution's student learning outcomes and standards of performance are clearly stated at the course, program, and, as appropriate, institutional level" (CFRs 2.2, 2.2a, 2.2b, 2.3).

The Commission also noted that "faculty and students are not in full agreement as to what a Caltech education consists of – that is, what the Core learning outcomes are." Choosing the

Core as one of our Thematic Pathway for Reaffirmation (TPR) foci impelled us to revisit and strengthen the Core Curriculum learning outcomes, and to ensure that whatever changes were made were aligned with our mission, our institutional learning outcomes, and WSCUC's five Core Competencies. Although we are closer to "full agreement" than in 2010, we are still actively debating "what a Caltech education consists of," and most likely always will. For example, the campus has been engaged in a deep, data-driven, and campus-wide discussion, led by the Core Curriculum Steering Committee (CCSC), which recommended adding a computational requirement to the Core. We believe that this painstaking process is a positive example of how the shared responsibility for the Core has worked. Whether a current Core class is taken out to make room for this new requirement is still being discussed. Also, 40% of students surveyed would like the Humanities and Social Science (HSS) requirement reduced; however, the majority of graduating seniors say that Caltech does not significantly strengthen their writing skills. The CCSC, along with other institute committees, will continue deliberating this issue.

"Significant faculty involvement" has been the hallmark of our approach to the Commission's recommendations, and with the CTLO effecting major changes to pedagogy, which are then assessed, we are much better positioned than in 2010 to "ensure that the standards of performance established by the institution are being achieved" (CFR 4.4). The [CTLO in-depth assessment](#) reports having, since its inception, "worked with 335 unique faculty members," a number that includes part-time faculty, lecturers, emeritus, and postdoctoral instructors.

We have striven to "regularly involve" appropriate stakeholders in the "assessment and alignment of educational programs" (CFR 4.5). Students routinely serve on essential institutional committees, such as the Core Curriculum Steering Committee (CCSC) and the Committee for Undergraduate Education (CUE), in addition to convening their own committees to which faculty and staff are invited, such as the Academics and Research Committee (ARC) (CFR 2.5) The Board of Trustees' Student Experience Committee, on which several alumni serve, is consulted on

matters related to the Institute's education programs. Visiting committees, comprised of trustees, alumni, and faculty from other institutions, advise and assess the activities of our six academic divisions. These "multiple constituencies" comprising the visiting committees are part of Caltech's system of evidence-based "institutional reflection" that help us "articulate priorities, examine the alignment of our purposes, Core functions, and resources, and define the future direction of the institution" (CFR 4.1, 4.6). Visiting committees typically take place once every five years, and are one of the formal mechanisms in place to ensure that Caltech's programs "are subject to systematic program review" (CFR 2.7) Other mechanisms include the Institutional Research Office (IRO), which analyzes retention and graduation rates, the Accreditation Board for Engineering and Technology (ABET) licensing program in the Mechanical Engineering (ME) option, and curriculum committees within divisions that conduct program reviews (CFR 2.1).

Since the last accreditation cycle, we have strengthened "an assessment infrastructure adequate to assess student learning at the program and institution levels" (CFR 2.6). The 2014 revisions to the Core, undertaken by the Core Curriculum Task Force, depended on an assessment structure that yielded the data that guided those changes. In the fall of 2016, however, our Chief Institutional Research Officer (CIRO) departed Caltech. In their absence, the assessment of student learning was conducted by offices across campus. In 2018, we hired Dr. Malcom-Piqueux, who leads Caltech's Office of Institutional Research. She has transformed our capacity to assess student learning and has put into place a foundation that reaches the entire campus and upon which we rely in making evidence-based decisions. One of her primary responsibilities is the collection, analysis, and interpretation of data related to student outcomes, student experiences, and the institutional environment. The purpose of this work, much of which can be found in the [Data Appendix](#), is to facilitate regular assessment of the Institute's academic and co-curricular programming and activities, and to inform ongoing and future educational practice. Dr. Malcom-Piqueux serves a broad range of internal audiences including senior leadership, academic deans,

the Board of Trustees, the Faculty Board and other faculty-led governing bodies, and student affairs directors and staff (CFR 4.3). External audiences include federal government agencies, higher education associations, WSCUC, and institutional consortia (e.g., AAU, COFHE, AICCU). She is also the primary representative to the Association of American Universities Data Exchange (AAUDE), and the lead IR contact to the Consortium of Financing Higher Education (COFHE) and the Consortium for Student Retention Data Exchange (CSRDE). In addition to coordinating data submissions to these data-sharing consortia, the CIRO regularly compiles peer comparison data for indicators of interest (e.g., retention rates, completion rates, time-to-degree) for benchmarking purposes (CFR 1.2). The CIRO also coordinates Caltech's participation in COFHE and AAU surveys of undergraduates, graduate students, and alumni in order to monitor institutional outcomes and effectiveness. Many of these surveys, including COFHE's Enrolled Student Survey, Survey of New Students, Senior Survey, Alumni Survey, and the AAU Campus Climate Survey on Sexual Assault and Sexual Misconduct, form the basis of trend analyses for a variety of measures of student engagement, experiences, learning, and academic and employment outcomes. By centralizing these activities in the Office of Institutional Research, the CIRO serves as knowledge and data manager to inform educational assessment and support institutional decision-making. (CFR 2.10, 4.2)

COMPONENT 2: COMPLIANCE WITH STANDARDS

Completing the Compliance with Standards worksheet was a collaborative effort that included the offices of the President, Provost, Institutional Research, Audit Services and Institute Compliance, Business and Finance, Strategy Implementation, and Human Resources. What emerged from the process was the profound commitment of each office to define precisely its role, to uphold ethical standards, and to empower every member of the community to flourish. The Compliance with Standards worksheet also reveals the extent to which the Center for Teaching, Learning, and

Outreach (CTLO) has had a profound effect on Caltech's culture. The frequency with which the CTLO appears as evidence of our compliance with a particular Criterion for Review is remarkable, whether the CFR is about learning outcomes, instructional innovation, or assessment.

Completing the IEEI was also a campus-wide effort that included the six divisions, executive officers, option managers, and the Graduate Studies office. The following patterns emerged: 1) all divisions participate in program reviews; 2) the data and evidence used to determine whether graduates have achieved stated outcomes is consistent across the divisions; 3) degree requirements are clearly outlined on all division websites; 4) all divisions participate in the Student-Faculty Conference and use Teaching Quality Feedback Reports (TQFRs), research theses, and placement results to determine if graduates have achieved stated degree outcomes. These processes create open and frequent channels of communication between students and faculty; 5) all divisions have program learning outcomes, institutional learning outcomes, and Core Curriculum learning outcomes on their websites.

Under the leadership of Dr. Malcom-Piqueux, we plan to engage in an even deeper mode of assessment; for example, understanding the mechanisms that go into the assessment of graduate and senior theses. We see an opportunity to work with divisions to track better the publications generated by our Ph.D. students. The CIRO is currently working with the director of the Career Development Center (CDC) to develop a first destination survey for undergraduate and graduate students, which will provide data about their academic and career paths.

COMPONENT 8: INSTITUTION-SPECIFIC THEMES

Origins of the Themes

Caltech's Accreditation Steering Committee (ASC) was established in 2018, and guided the effort to identify themes in a series of meetings with institute committee leaders, faculty, undergraduate and graduate students, and staff. Feedback was consistent. The **Core Curriculum** and **Academic**

and Co-curricular Support Structures were the two themes that would allow us to evaluate and reflect upon changes implemented since 2010. They also reflected our commitment to the **Four Standards of Accreditation**. First, there was no doubt that the Core should be a theme because it is one of Caltech’s “distinctive elements,” exemplifying our “essential values and character” (**Standard 1**). Also, the Core was a theme in 2010, and the Commission had recommendations that we had addressed and wished to revisit. Second, we wanted to examine support structures that existed within and outside of the six academic divisions that promoted students’ academic success and well-being. Support structures had been created, strengthened, and/reorganized since 2010, illustrating the Institute’s commitment to achieving “its educational objectives through investments in . . . key resources and organization structures [that] promote the achievement of institution purposes and educational objects, and create a high-quality environment for learning” (**Standard 3**). This second theme would focus on our “Core functions of teaching and learning, scholarship and creative activity, and support for student learning and success” (**Standard 2**). It would also capture our commitment to improving the student experience, assess how we were meeting our community’s needs and expectations, whether in the classroom, the counseling center, the library, the deans’ offices, etc. “The results of [this] institutional inquiry, research, and data collection” would be used to “establish priorities, to plan, and to improve quality and effectiveness” (**Standard 4**).

Theme 1: The Core Curriculum (CFRs 2.2, 2.2a, 2.4, 2.5, 2.6)

A 2014 article in the Tech, Caltech’s newspaper, featured Professor Geoff Blake, now Chair of the Faculty Board. He was asked, “why do you think Core is important?” and replied, “You may be a mathematician, but there are going to be issues that may involve your personal life and your family in terms of medical decisions, bioethics. Having no background in those fields whatsoever makes you a fairly narrow scientist and member of society. That’s sort of the idea behind a so-called

liberal science education. You get at least some grounding in the various kinds of sciences and hopefully engineering as well. You may change careers many times over the course of your lifetime. That's why I think Core is important." The Fall Core Survey, which can be found in the Appendix, indicates that over 92% of first-year students attended the 2019 orientation panel on the Core, where alumni discussed its importance to their lives after Caltech, as well as the benefits of non-STEM Core components, such as Humanities and Social Science (HSS) courses and physical education. The dean's office added this panel based on feedback from frosh advisors indicating that students needed more information about the Core prior to the start of their first year. This panel was an effort to correct that, and because students responded so positively to this innovation, we will keep it as part of freshman orientation. (CFR 2.5)

The consistency with which the Core is discussed and evaluated, from the perspectives of both students and faculty, is evident in the work of committees specifically appointed to consider the effectiveness of the Core, such as the Core Curriculum Steering Committee (CCSC), the Faculty Board, The [Committee for Undergraduate Education \(CUE\)](#), the Academics and Research Committee (ARC), and the committees with curricular oversight responsibilities within the six divisions. These committees work together to evaluate the content of the Core and the way students experience it. For example, homework sets for Core classes were adjusted due to concerns expressed in ARC meetings that students were not getting enough sleep and experiencing increased levels of stress. This last point has been confirmed by Core Curriculum Working Group (CCWG) data showing that increased stress levels among Caltech undergraduates mirror national levels (A.1). The Vice Provost, in concert with the Undergraduate Dean's Office, the CCSC, and CUE, initiated a plan to change the deadlines and stagger the days of the week when homework was due. Student leaders in ARC noted that informal feedback channels pointed to a beneficial effect on student well-being. An excellent example of the intersecting lines of communication around the Core is the biannual Student-Faculty Conference (SFC), an essential

assessment tool, which one professor called an “Institute focus group.” In 2017, the Tech described a panel about the Core, in which five professors and Dr. Jenn Weaver, CTLO’s Associate Director for University Teaching and Lecturer participated. Three undergraduates presented their findings to the Faculty Board. This SFC provided feedback that helped motivate the Inclusive Caltech Core (IC²), which led to pedagogical improvements.

The 2010 letter observed that the work done on the Core “has resulted in greater clarity about its rationale and several key course changes.” The visiting team pointed out the need for further study and assessment “to validate the current curriculum and/or guide additional changes,” and instructed us to “address the need for a coherent voice that articulates the Core Curriculum rationale to the larger Caltech community in order to foster support for the Core and its alignment with Caltech’s mission.” Caltech has spent the last several years responding to this recommendation by developing, through a deliberative process that, more often than not, yielded consensus, and implementing a variety of institutional changes. Some changes directly related to the content of the Core; some addressed the entire Caltech experience of which the Core is a vital part; and some aimed at improving and assessing the student experience of the Core. Major initiatives include: 1) **the 2013-14 revision of the Core**, which CCWG data show had the desired effect of increasing the percentage of first-year students who enrolled in research units for courses featuring discussion of emergent research topics (A.5); 2) **the 2016 four-year student experience committee**, which had the desired effect of decreasing the number of students overloading in their first year, decreasing the number of students underloading in their senior year, and evening out the number of units attempted per term (A.4); and 3) **the 2017 IC² Project**, which had the desired effect of showing faculty how to incorporate more inclusive and evidence-based teaching practices within the Core (C.2). IC² involved 15% of the faculty, with a concentration on those teaching in the Core, and helped to achieve consensus – “a coherent voice” -- on the Core learning outcomes. Each of these topics will be elaborated upon in the CCWG materials. From 2018 to 2020, our

efforts around the Core focused on examining and strengthening the learning outcomes. This has been an Institute-wide, evidence-based endeavor that yielded fruitful interdisciplinary debate and a renewed set of Core Curriculum learning outcomes that the entire campus has endorsed.

Key Findings from the Core Curriculum Working Group (CCWG)

The appendices for the CCWG present the range of data collected and assessed; however, this section of the institutional report will delineate some high-level findings. We have learned:

- Faculty strongly endorse the Core Curriculum, though there is debate about the content, especially whether or not computer science should be added to the Core. Over 90% of the faculty who responded to the survey about the Core agreed that Caltech should have a Core. 93% agreed with the mission and rationale of the Core as explained by the Core Institute Requirements (2019-20 catalog, p. 233).
- The academic workload in the Core is the most significant source of stress for our frosh (**A.2**), and the first quarter mathematics class and the experimental laboratory chemistry class stand out for their difficulty. The data show that the math classes with their more intuitive approach to the subject matter, challenges students whose high school training has been more computationally-oriented (**D.1**). This data confirms the importance of encouraging students to complete Math 0, an introduction to proof-based mathematics that all incoming first year students have access to the summer before starting Caltech. The positive impact of Math 0, which was initially supported through the Innovation in Education Fund, on our introductory mathematics classes can be found in the Math 0 in-depth assessment.
- The impact of the Core on students' self-confidence requires further analysis (**E.1**; **E.3**). The data show that self-confidence decreases during the first year of the Core, with women's self-confidence registering a greater decrease than men's. Survey data from the

mid-quarter feedback surveys administered as part of IC² revealed that, on average, men in first-year Core courses reported no change in their intellectual self-confidence during their first term at Caltech, while women's intellectual self-confidence decreased during the same term. 34% of male frosh reported that their intellectual self-confidence was either weaker or much weaker at the midpoint of the Fall quarter compared to 55% of women. Gender differences in students' change in intellectual self-confidence were also present in the Winter and Spring terms. In the Winter and in the Spring, men reported an average positive change in intellectual self-confidence, while women reported negative changes (i.e., weakening) in their intellectual self-confidence, on average. In Winter, 28% of men reported weaker or much weaker intellectual self-confidence compared to 48% of women. In Spring term, 23% of men reported weaker or much weaker intellectual self-confidence compared to 65% of women. All of these gender differences are statistically significant, after controlling for grades. These statistics are unsatisfactory, and we are working to improve them in a number of ways: maintaining our work with Core faculty on inclusive pedagogical practices; continuing the Inclusive Caltech Core surveys (even though that AAU initiative is over) to collect data and monitor student self-confidence; and surveying the campus in an upcoming climate survey. The survey will help us determine to what extent this drop in self-confidence in women is due to classroom dynamics, living situations, and/or the environment in other spaces on campus.

- Surveys of first-year students and advanced students show that the Core has an important impact on what option(s) they will pursue. Over 50% of students enter Caltech knowing what their option will be, but the 43% who do not maintain that the Core plays some role in helping them to decide on an option. 65% of advanced students who filled out the survey noted that by the end of their first year, they had decided on their option. 70% of these students indicated that the Core prepared them for study in their option and almost 90%

said the Core expanded their learning in fields outside of their option” (E.2). One student memorably wrote about his Chemistry and Humanities classes, “I was inspired.” This data confirms that the Core is playing a key role in helping students determine their path forward.

- 90% of the faculty who filled out the survey indicated that the Core does an excellent job teaching students the Core Competencies of quantitative reasoning and critical thinking. Given the content of the Core, we would expect to excel in these Core Competencies. However, data suggests that the Institute should continue focusing on and investing in resources to improve student skills related to Written and Oral Communication, as well as Information Literacy (E.4). Discussions are underway for expanding the reach of the Hixon Writing Center, which would be one method for addressing this issue. Also, we intend to get a better understanding of why students postpone the scientific writing requirement, and the impact of this delay.

The CCWG Process

One of the CCWG’s primary tasks has been the strengthening of Core learning outcomes that capture the breadth and the depth of the Core. A set of broad learning outcomes were broken into component parts so as to measure and assess the degree to which objectives have been met. Updating these Core learning outcomes has involved the entire Institute, yielded institutional consensus, and thus “addressed the need for a coherent voice that articulates the Core Curriculum rationale to the larger Caltech community in order to foster support for the Core and its alignment with Caltech’s mission” (2010 Commission letter; CFR 2.2, 2.2a). There is overwhelming support for the Core and faculty recognize its alignment with Caltech’s mission. That said, faculty are committed to revisiting the content and delivery of the Core on an ongoing basis. In addition to developing **the Core learning outcomes**, the CCWG oversaw the development of **curriculum maps**, the **annotation of student work** for several of the most essential courses in the

Core, and the organization of **focus groups** that would provide qualitative data from a heterogenous set of student populations.

The work of the CCWG is detailed in the Appendices and in the Core Curriculum cover document, but below we provide a high-level overview. The revised learning outcomes were presented at divisional faculty meetings, the Institute Administrative Council, a body comprised of leadership – faculty and staff – across the campus, the Board of Trustees, the Committee for Undergraduate Education, The Core Curriculum Steering Committee, the Faculty Board, and the student-run Academics and Research Committee (**CFR 2.4; C.3**).

Learning Outcomes. Strengthening the learning outcomes was one of the most significant and challenging accomplishments of the Core Curriculum Working Group (CCWG). The philosophical statement about the purpose of the Core helped the CCWG generate, with feedback from the Caltech community, a set of specific and assessable Core learning outcomes. The statement reads: “A Caltech education requires not just the depth of an option, but also considerable breadth in basic science, humanities, and social science. Caltech’s Core Curriculum prepares students for the interdisciplinary nature of contemporary research in science and technology. This encourages a culture of problem solving, collaboration, and communication while providing valuable experience in all fields of science. Significant study in the humanities and social sciences is an important component of Caltech’s Core Curriculum giving alumni the ability to navigate the societal, political, and economic factors that influence, and are influenced by, their work.” (**CFR 2.2a**)

The CCWG used the broad statement of educational outcomes as the foundation from which to develop clear and measurable learning outcomes that would allow us to assess, at the micro-level, the process of student learning. Revising this statement was admittedly challenging on a number of fronts, the most important being the Caltech culture of giving faculty a great deal of discretion in what they prioritize in their classes and how they assess student learning. Asking

faculty from a range of disciplines to reach consensus on priorities and assessment required them to commit to agreed-upon goals and aims that were not always exactly in sync with their individual perspectives.

The following learning outcomes were endorsed by the Institute.

The Caltech Core Curriculum provides:

- **Substantive experience in problem-solving, collaboration, and communication.**

Students will be able to . . .

- a) Manage increasing academic challenges while developing resilience and confidence.
- b) Develop and satisfy their intellectual curiosity.
- c) Collaborate effectively and ethically, recognizing diverse models of academic collaboration.
- d) Communicate to a range of audiences through a variety of media.

- **A broad and rigorous foundation in the sciences.**

Students will be able to . . .

- a) Demonstrate understanding of foundational concepts from the sciences.
- b) Use disciplinary thinking, analytical skills, and a range of methods in the sciences.
- c) Apply their knowledge and skills to diverse problems within and across disciplines.

- **Significant study in the humanities and social sciences.**

Students will be able to . . .

- a) Explore and expand upon learning in fields beyond intended areas of specialization.
- b) Appreciate and understand the contributions of the humanities, social sciences, and arts to human endeavors.
- c) Engage in informed analysis of cultural, political, and economic issues.

Curriculum Maps and Narratives. Following the development and adoption of the Core learning outcomes, the CCWG turned toward mapping the Core. This process would identify where within the Core students work toward each outcome and ensure alignment between the Core and the learning outcomes. Similar to the collaborative manner in which the Core learning outcomes were redefined and recalibrated, the working group wished to engage faculty in the curriculum mapping process. The Core faculty debated the revised learning outcomes and how they would be used to fill out curriculum maps in a series of meetings during which the process by which the Institute had arrived at these expanded learning outcomes and their pedagogical value was explained. Faculty discussed the interdisciplinary nature of the Core, the differences between direct and indirect assessment, and how their own course fulfilled their expectations for student achievement. The curriculum maps visually represented how faculty assessed student learning in relation to the learning outcomes (CFR 2.6).

The goals of these curriculum map meetings were to educate the community about learning outcomes and to bring together faculty teaching in the Core so they could see how the learning outcomes connected them to one another as they worked towards the common goals and the shared objectives, that comprise the Core learning outcomes. The curriculum maps visually captured this process, but it was just a start. We needed to put them into narrative form, by discipline, so we could have clarity about precisely what these maps were telling us. We learned that there is consistency within and across disciplines about the learning outcomes, especially in the areas of collaboration, problem-solving, and communication. The consensus achieved is visible in the maps, but slight divergences appear. Most faculty in the Core expected students to achieve an introductory level of knowledge, while others expected that students would achieve an advanced level of knowledge. In some cases, the curriculum maps – especially those in the Menu classes – revealed a range of expected outcomes with some courses focused more on foundational concepts and others on the application of concepts. We believe that the diversity of

responses is predictable, and a function of individual faculty teaching styles as opposed to widely different expectations.

The curriculum mapping exercise, and its narrative distillation, allowed us to see that the Core classes were consistently meeting the Core Curriculum learning objectives that the CCWG had established as desired outcomes. An emphasis on problem solving and collaboration not only appears, as expected, in physics and math classes, but also in the freshman humanities classes where “effective collaboration is modelled in class discussion and through peer review writing workshops” ([Introductory Humanities Curriculum Map Narrative](#), p. 3). The interdisciplinary nature of the Core, as well as individual classes in the Core, is apparent in courses as distinctive as [Applied Physics/Electrical Engineering 9](#), where physics, chemistry, and electronics are covered, and [History 135](#), where students are “expected to conduct a literature review search, summary, and section of prospectus that uses methodological tools from the sciences to complete.”

The curriculum map sessions were especially valuable because they gave faculty a chance to debate priorities with one another, to discover areas of intersection despite disciplinary distinctions, and to share practices of assessment. Less consistent, however, is the extent to which Core classes prioritize exploration, appreciation of other disciplines, and informed social analysis. Although some STEM classes indicate that this is a learning outcome, much of this work is done primarily in the Humanities and Social Science classes. We see an opportunity to bring into greater alignment the learning outcomes across the whole Core, and a willingness to do so. STEM faculty in the curriculum map meetings were interested in determining how to integrate into their own courses outcomes that were the focus of the humanities and social science faculty. Going forward, the curriculum map exercise will be a fixture as we assess how well the Core, in its entirety, addresses the learning outcomes.

In matters of assessment, the picture was heterogeneous. Some classes relied almost solely on quizzes and exams, while others incorporated writing assignments and hands-on

projects. Some courses indicated an expectation of a learning outcome, but didn't have an assessment tool to see if the outcome had been achieved. We intend to continue this curriculum map exercise, which was an innovation in this TPR, and in doing so hope to fill in this blank and ensure that learning outcomes are uniformly assessed.

Annotation of Student Work. The CCWG agreed that the faculty members from each division should annotate student work as one more data point in determining the degree to which learning outcomes were being achieved. Annotated work was a feature of the 2010 assessment, but we wanted to analyze the work at an even deeper level. Staff throughout the divisions assembled representative student work, including problem sets, final exams, and analytical essays. Faculty annotated the materials, foregrounding where the learning objectives were met and where student learning could be improved. This exercise enabled faculty to visualize and articulate, in a concrete and detailed way, the basis for their assessments. Moreover, the exercise proved valuable for faculty members themselves, with several saying that the annotation process helped them see new ways of rewriting problem sets that would potentially improve student achievement on learning outcomes. They not only looked forward to collecting data to find out if these revisions would have the desired effect, but also to make this mechanism of direct assessment a regular practice as part of an ongoing assessment of the Core (E.5).

Moreover, the annotation of student work allowed us to see the objective measures and careful considerations used by faculty in determining student achievement. In the case of Ma 1a, the professor tells the students, "you must give details of all your assertions. What is important is not just the final answer, but how you got there." This professor followed the trajectory of four students in the class to determine whether the learning outcomes were achieved. His conclusion, based on the results of the final exam was, "They have made significant progress in the course all told, as in the beginning of the term, all they could do was to plug in formulas for the text or the

notes blindly and calculate . . . , Now they at least know that critical reasoning and proper justification are required.” (CFR 2.6)

Student Focus Groups. The working group convened six hour-long focus groups on the Core in order to gather rich qualitative data about student experiences in the Core and to understand the extent to which students feel that the Core provides opportunities to achieve the Core Curriculum learning outcomes. Three focus groups brought together first-year students, while the remaining three focus groups consisted of advanced-level students--sophomores, juniors, and seniors. Using a semi-structured focus group protocol, the Chief Institutional Research Officer facilitated conversations about how the Core helped students learn to manage academic challenges, explore their intellectual curiosity, and collaborate effectively. Advanced students were queried about whether and how the Core prepared them for study in their option. All students were asked to consider how their experiences in HSS courses enhanced their critical thinking skills, ability to communicate, and ability to make cross-disciplinary connections. A thematic analysis of the focus group transcripts revealed that while students feel the Core is extremely challenging, they agree that the experience results in a strong foundation across a broad range of scientific disciplines. This qualitative data nicely confirmed the quantitative data we had collected from the surveys about the Core. First-year and advanced-level students emphasized that beyond the sheer volume of work, success within the Core requires that they develop intuitive ways of thinking, far beyond the computational acumen that helped them achieve success in high school (D.1). Participants also described the centrality of successful collaboration within the Core, and beyond. Advanced-level students felt that the Core allowed them to experiment and find collaborative approaches that enhanced learning. However, some first-year participants described collaboration, and relatedly, Office Hour and TA shopping, as a survival tactic that ensured they could pass their courses (D.2).

Each focus group discussed at length student experiences within Humanities and Social Sciences (HSS) courses. Views on the utility of HSS courses in the Core were highly polarized, with some students describing HSS courses as a welcome respite from the intense STEM-focus of Caltech and others describing HSS courses as an undesired diversion from their focus on their option. Across the focus groups, participants agreed that the value that students derived from their HSS courses depended on the attitude that students brought to the classroom. As multiple students stated, “you get out [i.e., learn] what you put in.” From the perspective of the focus group participants, humanities courses required a different type of critical thinking from students because they are required to craft arguments and use evidence to support those arguments, but there are “no right answers.” The focus group participants tended to agree that humanities courses allowed them to improve their writing skills but disagreed about whether humanities courses required too little or the right amount of writing.

The advanced-level student focus group data revealed that some students were dissatisfied with social science courses that were “math courses in disguise.” Students generally felt that an overabundance of social science courses focused on mathematics and required computation-heavy problem sets instead of writing assignments. Students conceded that this type of work was better suited to their strengths, but also felt that these courses do not seem geared toward developing the students’ understanding of broader social issues. This qualitative data confirms the survey results that indicate improvements are necessary with respect to the writing skills Core competency. Although we added a writing-intensive Social Science requirement in our Core revision, it may be that more writing should be part of the curriculum – in social science classes, as well as STEM courses.

COFHE Senior Survey Data. Beginning in 2010, Caltech participated in the COFHE (Consortium on Financing Higher Education) Senior Survey. The survey, administered to graduating seniors in April of their final year at Caltech, provides students’ self-assessment of gains in their

knowledge, abilities, and skills since entering Caltech. Though students are not specifically asked to describe the contribution of the Core to their learning, several domains about which they are queried align with the Core learning outcomes. The COFHE Senior Survey asks students to indicate the extent to which their experience at Caltech contributed to their knowledge, skills, and personal development related to writing clearly and effectively, communicating well orally, placing current problems in historical, cultural, and philosophical perspective, and evaluating the role of science and technology in society. These four items relate to the Core learning outcomes that emerge from the significant study in the humanities and social sciences required by the Core. In 2018, the most recent Senior Survey data available, 40% of respondents indicated that their experience at Caltech contributed ‘very much’ or ‘quite a bit’ to writing clearly and effectively. Just over 49% of respondents indicated that their experience at Caltech contributed ‘very much’ or ‘quite a bit’ to their oral communication skills, and just below 30% of respondents indicated that their experience at Caltech contributed ‘very much’ or ‘quite a bit’ to their ability to place current problems in historical, cultural, and philosophical perspective. Nearly 57% of respondents to the 2018 Senior Survey responded that their experience at Caltech contributed ‘very much’ or ‘quite a bit’ to their ability to evaluate the role of science and technology in society. 57.5% of students complete their scientific writing requirement during their senior year, and we need to collect additional data to determine if that is too late in their Caltech career to have the desired benefit. These statistics indicate room for improvement. As mentioned in the curriculum map section of the report, we need to work with faculty in the Core to find ways of integrating cultural contexts into their discussion of scientific content. The curriculum map meetings provided just such an opportunity, and we will continue that interdisciplinary exercise. Such efforts are ongoing and are part of the work of the Center for Teaching, Learning, and Outreach and the Center for Inclusion and Diversity.

Though students develop their understanding of and ability to use quantitative reasoning and methods, critical thinking abilities, in-depth knowledge of a field or discipline, and effective functioning as a member of a team both in the Core and within their option, it is instructive to examine how students describe Caltech's contribution to those domains as well. In 2018, the most recent year for which COFHE Senior Survey data are available, 90% of respondents indicated that their experience at Caltech had contributed 'very much' or 'quite a bit' to their ability to understand and use quantitative reasoning and methods and just above 88% said that Caltech contributed 'very much' or 'quite a bit' to their critical thinking abilities. Nearly 87% of respondents indicated that Caltech contributed 'very much' or 'quite a bit' to their in-depth knowledge of a field or discipline, and just below 67% said the same about Caltech's contribution to their ability to 'function effectively as a member of a team.' We have taken steps to improve this percentage. Entrepreneurial programs on campus within the social sciences and the Technology Transfer and Corporate Partnership Office aim to work with students on improving these skills. Also, the Career Development Center has several programs that help students learn how to be effective members of a team. We look forward to seeing the next COFHE survey and hope that our efforts make a difference in our students' response to this question.

Data from the 2017 COFHE Alumni Survey are also instructive regarding student outcomes from the Core. Conducted every four years, the survey asks alumni to describe how well their undergraduate experience at Caltech prepared them in a range of areas. Items relevant to the Core include how well Caltech prepared alumni to understand social problems and to acquire broad knowledge in the arts and sciences. Of alumni who graduated from Caltech in 2011-2015, 58% responded that Caltech prepared them very well, more than adequately, or adequately to understand social problems. Nearly 80% of alumni from this period of time responded that Caltech prepared them very well, more than adequately, or adequately to acquire broad knowledge in the

arts and sciences. We believe that this data will be crucial as the campus debates changes to the Core that might involve a reduction in the Humanities and Social Science requirement.

Our self-study of the Core confirmed the importance of it to the Caltech community and its overall effectiveness. The conversations about the Core, both as a whole and its individual parts, illuminated the extent to which our revised learning outcomes captured overlapping priorities as well as divergences. Those divergences are expected given the capaciousness of the Core. A film class will probably not “demonstrate foundational concepts from the sciences.” Some learning outcomes simply will not overlap, but we do believe there are opportunities to deepen the connections across the Core. For example, if we agree that students will be able to engage in informed analysis of cultural, political, and economic issues, we should and will work across the Core classes to seize opportunities where this outcome can be achieved. The Core is a perpetual work in progress, and we look forward to making it even stronger and more connected than it already is.

Theme 2: Academic and Co-Curricular Support Structures (CFRs 1.4, 2.8, 2.11-2.13, 4.1-4.4)

Although Caltech has been described as “a uniquely difficult but wonderful place to study” (Allison Wang, *Times Higher Education*, September 30, 2019), we work hard to have support structures in place so that every one of our talented undergraduates has the capacity to thrive. References to the difficulty of the Caltech curriculum are not uncommon. The University of Edinburgh study abroad website includes this message to students who wish to participate in our exchange program: “Caltech is one of the most rigorous universities in the world. Students spend at least 40 hours a week on coursework and preparation, and often more. Students interested in Caltech must be intelligent, very hardworking, and willing to stretch themselves to their intellectual limits.” The Caltech Undergraduate Admissions website notes, “a student’s first-year experience creates important scaffolding for their sophomore year, which is known as the most challenging year in a

student's undergraduate career here. Thus, an admissions decision centers on the Admissions Committee's confidence that a student will succeed in this rigor in their first year *and beyond*.”

Caltech undergraduates in the twenty-first century are prepared to take on a curriculum designed to challenge and inspire them. However, as at other institutions of higher learning, an increasing number of students confront difficulties related to mental health, time management, feelings of belonging, and/or socio-economic insecurity. Here, we discuss the strategies, developed from data, that Caltech has deployed in response to these realities. What will become clear in this section of the report is that the infrastructure aimed at supporting students has expanded significantly with the aim of improving the student experience and addressing issues that our changing population faces.

In 2016 Professor Joseph Shepherd, C.L. “Kelly” Johnson Professor of Aeronautics and Mechanical Engineering and Vice President for Student Affairs (VPSA) updated the Faculty Board on Caltech's student affairs organization. Most relevant are the changes made to the Health and Counseling Services, which include two new positions: “a full-time specialist in alcohol and other drugs who is a licensed psychologist, and a full-time crisis intervention coordinator who is a licensed clinical social worker.” More recently, Student Wellness Services (SWS) hired Dr. Grace Ho, an occupational therapist, who assists students with planning and organizational skills. In 2018, Dr. Hanna Song, senior director for diversity, explained to the Faculty Board the reorganization and expansion of the Freshman Summer Research Institute: “a 5-week experience where selected students (identified as URM, women, first generation) are paired up with a mentor, live on campus with each other during the summer, and build a cohort.” In 2016, the University librarian informed the faculty that there would no longer be a charge for interlibrary loan requests. This policy was implemented based on [data showing that graduate students and postdocs used ILL less due to charges that accompanied the service](#). Removing the charges led to equal access and increased usage, especially among postdocs, graduate students, and undergraduates.

Tech articles illustrate enthusiasm for these support structures. In a 2012 interview with CTLO's founding director, Dr. Cassandra Horii described her goals for the new office, and noted, "it is fantastic that students are so involved in the process of teaching and learning at Caltech. From the moment I stepped on campus, the ARC [Academics and Research Committee] was part of the process for me, and I got to know the people and the mission of the ARC." Tech articles and announcements routinely highlight the integral role of support structures in the students' lives.

The Support Structures Working Group (SSWG) was established in 2018 in order to collect data about our support structures and to develop and implement an assessment strategy that would allow us to see what structures were effective, who used them, and how often (CFR 4.2). Faculty and staff leadership worked together to understand the impact made by individual support structures and how they worked together to create a system of support. The data compiled and analyzed by the SSWG helps us understand the quantitative and qualitative aspects of these support structures. Who is using them? How many students are using them? [Which structures are most used?](#) Are multiple structures being accessed? Are they helping students? How might they be improved? [Are other structures necessary?](#) (CFR 2.11) It is important to note that the expansion of support structures exceeded Caltech's institutional capacity for assessment, and we have been catching up ever since. Data collection practices vary across these support structures, and depend upon capacity and expertise. This TPR theme allows us to lay the groundwork for establishing our desired standards of assessment.

Key Findings of the Support Structure Working Group (SSWG)

The appendices for the SSWG present the range of data collected and assessed; however, this section of the institutional report will delineate some high-level findings. We have learned the following:

- The support structure surveys show a collective and well-organized effort, within divisions and outside of them, to provide a variety of support structures that are designed to facilitate

the successful completion of a Caltech degree. Surveys and focus groups demonstrate the Institute's commitment to curricular review and improvement; teaching innovation; the cultivation of formal and informal networks of advising and mentoring; and student enrichment through faculty/student interaction. Although each division offers a different suite of programs, customized to the specific nature of the disciplines and the needs of their students, the divisions share a set of values that align with the objectives outlined by the SSWG. With this theme, we are for the first time both examining the support structure programs, offerings, and activities and assessing these structures in relation to one another.

- The academic and co-curricular support structures are deeply connected, and their boundaries are porous. The proliferation of academic programming related to diversity and inclusion is notable. The Caltech Center for Inclusion and Diversity (CCID) plays a central role in organizing and often leading these programs; for example, speaker series with a focus on women and/or URMs bring in scholars who then discuss their research and identities. Similarly, recruitment efforts and diversity training take place within the divisions and are led by staff in the CCID and the Equity and Title IX Office. Academic divisions coordinate the advising and mentoring of their students, but Student-Faculty Programs runs an annual mentoring conference with significant student, postdoctoral, and faculty participation. The expansion of the Hixon Writing Center in 2016 to include a specialist in STEM writing meant that academic divisions were better able to leverage this resource, which led to the hiring of a second STEM writing specialist in 2017. The Center for Teaching, Learning, and Outreach (CTLO) works with faculty in developing proposals for the Innovation in Education Fund. Like the Innovation in Education Fund, which incentivizes creative pedagogy, the Moore-Hufstедler Fund encourages and supports creativity and community enrichment. **(CFR 2.8)**

- Collaboration and coordination across many of the support structures is an exciting development and is increasingly common. This section of the report, as well as the in-depth assessments, will provide examples of these partnerships.
- Assessment of support structures takes place both directly and indirectly. How these programs succeed in meeting the eight objectives, as articulated by the SSWG, is assessed through a variety of mechanisms: the Teaching Quality Feedback Report (TQFR), the bi-annual Student-Faculty Conference (SFC), the bi-annual Graduate Student Colloquium (GSC), exit surveys of graduating seniors, and alumni surveys (CFRs 4.2, 4.3). As was noted in 2010, Caltech's small size also allows us to conduct frequent and illuminating indirect assessments.

The SSWG Process

The process of assembling the materials in this section of the TPR was deliberative, collaborative, and rigorous. The Support Structures Working Group 1) determined the **objectives** that the support structures aimed to achieve; 2) decided which support structures would be included in the **data collection**; 3) created a **rubric** that would elicit the data that we wished to collect and analyze; 4) examined the survey data in relation to the objectives, and wrote up **analyses in narrative form**; 5) decided which support structures would most benefit from an **in-depth assessment**; 6) followed up the more quantitative survey data with **focus groups** that would provide additional qualitative data; 7) developed **surveys** to determine usage, effectiveness, and coordination of support structures among the undergraduate and graduate student populations; 8) coordinated the **assessment, analyses, and narrative of the data**.

Objectives. Initial meetings of the SSWG reviewed the range of support structures across campus, and their missions, and drafted the following set of objectives:

- Improve instructional quality and teaching practices (CFR 4.1)
- Promote student learning and success

- Support students as they navigate their degree program(s) (CFR 2.12)
- Prepare students for their careers after Caltech
- Engage students in meaningful learning and research in science and engineering
- Provide access to mentors and mentoring
- Build community and foster students' sense of belonging
- Cultivate an inclusive learning environment (CFR 1.4)

Support Structures. The list of co-curricular support structures includes: the Undergraduate Dean's Office, the Graduate Studies Office, the Center for Inclusion and Diversity (CCID), the Center for Teaching, Learning, and Outreach (CTLO), Student Wellness Services (SWS), the Registrar, Career Development Center (CDC), Caltech Y, International Student Programs, Hixon Writing Center (HWC), Student-Faculty Programs (SFP), Athletics, Fellowships Advising and Study Abroad (FASA), the Equity and Title IX Office, Office of Residential Experience (ORE), Performing and Visual Arts (PVA), and the Library.

Survey. With the support structures designated, the SSWG created and disseminated a survey that linked specific programs/activities and their ability to meet the agreed-upon objectives. Surveys were sent to the directors of the support structures and completed.

- Indicate the name of the program/activity.
- Select which of the eight objectives that the program/activity meets.
- Describe how the program/activity meets the selected objectives.
- Indicate what, if any, data is collected about the program/activity, including what data is collected to assess the effectiveness of the program/activity.
- Describe what, if any, additional components the office would implement for that program/activity, if the resources were available.

The committee also surveyed the academic divisions. Because the support structures operate at the undergraduate and graduate levels, SSWG outreach to the divisions was extensive and included division chairs, faculty, members, divisional curriculum committees, executive officers, option representatives, and staff.

Having made academic and co-curricular support structures one of our TPR themes, Caltech now has all of this information in one place. As with the Core Curriculum, ongoing assessment of them will be guided by the Accreditation Steering Committee.

Analyses. With the surveys completed, the SSWG evaluated the data. Evaluation was organized according to learning objectives, with committee members determining which support structures were meeting which learning objectives. In order to ensure consistency in the execution of this task, the SSWG developed a set of questions that each team would use:

- Achievements: How well are the support structures (as a whole and individually) meeting the objective? In what ways? What are the measures of success?
- Challenges: Where are the gaps/unmet needs related to this objective? What challenges are the support structures (as a whole and individually) facing in meeting this objective? How do we know?
- What further questions do we have?
- Should this program/department be highlighted in the report?

To organize this data, the SSWG asked the faculty members on the committee to put into narrative form the survey responses (**CFR 4.4**). We learned that for undergraduates, support is frontloaded in order to address a range of backgrounds and experiences. For graduate students, the support is overseen by the divisions and options, or even small units such as a research group or lab. The approaches to academic support vary, and some graduate students benefit from robust structures and others have unmet needs. Some divisions have hired a student affairs professional to develop

programming and support structures for students, and we believe that this may be an effective measure for all divisions to consider.

In-depth Assessment. The SSWG chose six support structures for the in-depth assessments. We not only wanted to demonstrate Caltech's deepened commitments to teaching, inclusion, student well-being, communication, et al., but also to develop a model for a more formal, regularized program review and assessment process. These assessments would assist us in improving our programs so that we can better serve students and wisely invest our resources. We selected the Center for Teaching, Learning, and Outreach (CTLO), the Caltech Center for Inclusion and Diversity (CCID), the Hixon Writing Center (HWC), Math 0, Student-Faculty Programs (SFP), and Student Wellness Services (SWS). Each office was given the opportunity to assess the entirety of its activities or to focus on a specific program. The in-depth assessments capture the intensity of the work being done by these support structures. Their commitment to data collection is an achievement we hope to see replicated throughout the Institute. This may involve additional staffing and/or training, and is an issue that we will be addressing going forward as support structures rotate through the in-depth assessment process we have begun with this TPR. Below is a brief, high-level description of the six in-depth assessments:

CTLO: The Center for Teaching, Learning, and Outreach has transformed pedagogy at Caltech. In its first five years, beginning in 2012, the CTLO interacted with 85% of all faculty, and that percentage now stands at close to 100. Whether meeting one-on-one with TAs or faculty, organizing TeachWeek, liaising with the Pasadena school system to create outreach programs, developing a course-design class, or leading the Inclusive Caltech Core (IC²) initiative, the CTLO, under the direction of Dr. Cassandra Horii, has demonstrated its impact on teaching methods, student learning, and other areas through direct and indirect assessment. In 2016, the Institute awarded the inaugural team impact award to CTLO in recognition of its significant contributions to Caltech.

CCID: The Caltech Center for Inclusion and Diversity assessed its redesigned Freshman Summer Research Institute (FSRI). In each of the last two years, for example, over eighty students competed for ~22 spots. FSRI prepares students for the Ma 1a Core course, teaches them collaboration skills (see CCWG Findings, **D.2**), and offers them a service-learning experience, which data show has a significantly positive impact on students. Qualitative data show the importance of the research experience, with students achieving key FSRI learning outcomes, including an experience of laboratory culture through exposure to group meetings and mentorship; and the creation of a formal presentation demonstrating research competencies, methodology, and outcomes. The CCID plays a critical role in developing students' Core Competency in **Quantitative Thinking**. Under the direction of Dr. Hanna Song, the CCID received the second annual team impact award.

HWC: The Hixon Writing Center was reconstituted in 2012-13 with the appointment of director Dr. Susanne Hall, who has transformed our writing program. During that first year, the HWC recorded 267 one-on-one meetings to discuss writing. That number has nearly tripled. Faculty in the humanities routinely leverage the HWC resources, often requiring students to attend a seminar on citation practices, and with the addition of STEM specialists, students have access to experts in scientific communication. HWC plays a critical role in developing students' Core Competencies in **Critical Thinking, Written Communication, and Information Literacy**.

Math 0: 90% of students who participate in Math 0, a summer course designed by Dr. Bob Pelayo, a Caltech alum and professor of math at UC Irvine, with input from the Caltech Math department, indicate that they are very satisfied or generally satisfied

with the course. Students who complete the entire ten-week online course perform better in Math 1a than students who do not. In addition, students who complete all of Math 0 are less likely to be placed in Math 1a section 1a, which is a section for students with weaker calculus skills. Even completing only one module of Math 0 correlates with a higher performance in Math 1a in comparison with students who do not. Data show that Math 0 plays a critical role in developing students' Core Competency in **Quantitative Reasoning**.

SFP: Approximately 90% of undergraduates complete research while at Caltech, whether during the academic year or in the summer, when they participate in one of the Student-Faculty programs, whether that is SURF, WAVE, Amgen, et al. The number of first-year students who SURF has almost tripled from 52 in 2003 to 147 in 2019. Because the motto of SURF is "Science not communicated is essentially science not done," SFP plays a critical role in developing students' Core Competencies in **Written Communication** and **Oral Communication**. Depending upon the content of the research project, other Core Competencies are frequently developed, including **Quantitative Reasoning**, **Critical Thinking**, and **Information Literacy**.

SWS: Student Wellness Services, and its reorganization in 2016 under the leadership of Dr. Jennifer Howes, has transformed and strengthened Caltech's ability to meet the increasing mental health needs of our students. SWS has established an integrated system of care that reaches into the academic divisions, the deans' offices, the CCID, the Equity and Title IX office, et al. This office also launched an innovative year-long pilot program that resulted in the creation of one of a handful of Occupational Therapy offices on college campuses.

Focus Groups. The SSWG determined that focus groups would provide important data about the usage and effectiveness of the support structures. The SSWG consulted with other institutions on best practices for the organization of the focus groups and appropriate protocols for the Accreditation Liaison Officer (ALO) who served as the facilitator. Questions posed to the focus groups aligned with the objectives agreed upon by the SSWG. Seven focus groups were convened, each with three to seven participants. Four groups met prior to the campus shutdown due to COVID-19, and three were done via Zoom. They included one group of URM undergraduate and graduate students (**CFR 1.4**); three undergraduate focus groups; and three graduate student focus groups, with one comprised of all women in order to delve into issues raised in the AAU climate survey. In addition, the focus groups were assembled in order to have participant diversity. Gender, academic discipline, house (i.e. dormitory) affiliation, athletic participation, country of origin, and URM status were considered.

Overall, the focus groups indicated a high degree of satisfaction with many of the support structures, confirming quantitative data from the surveys. Several support structures were consistently highlighted as effective, and specific programs within them were often praised. These were the Student-Faculty Programs, the Caltech Center for Inclusion and Diversity, the Center for Teaching, Learning, and Outreach, the Hixon Writing Center, and Student Wellness Services, especially Occupational Therapy. Students praised the Caltech Y, the Caltech Alumni Advisors Network, the Equity and Title IX office, and the Undergraduate Dean's Tutoring Program (**CFR 2.13**). Areas where the institute can improve include the Career Development Center (CDC) and faculty-student advising. Based on the data, significant changes have already taken place in the case of the CDC, with the recent appointment of a new director. The faculty-student advisor issue requires additional review. At the undergraduate level, a 2019 ["Student Success" initiative](#) has been undertaken, with coordination across the entire campus. The advising system beyond the

first-year programming will be considered. At the graduate level, additional data collection will provide the evidence-based information we need to respond to graduate student advising needs.

Summary of Support Structure Survey Data from Undergraduates and Graduate Students. To understand better student use of and satisfaction with Caltech's academic and co-curricular support structures, the SSWG administered a graduate student survey in June 2019 and an undergraduate survey in April 2020. The questions to graduate students were included on the larger Graduate Student Council (GSC) Quality of Life Survey, while the undergraduate support structure survey was standalone. Each survey asked students to indicate their primary source of support, the frequency with which they used specific academic and co-curricular support structures, and their level of satisfaction with the support structures used.

Nearly 47% of the 614 graduate students who responded to the survey indicated that their peers were their primary source of support as they progressed through their degree program. The second most common response was 'Advisor', with 37% of respondents indicating that their advisor was their primary source of support. Interestingly, disaggregating the data by gender revealed key differences. 43% of men indicated that peers were their primary source of support, compared to 54% of women. 41% of men identified their advisor as their primary source of support compared to 28% of women. This gender difference stands out, and we are hoping that the climate survey may help explain why. The support structures most frequently used by graduate students were Student Health Services (other than counseling services), Caltech Athletics/Recreation, and the Graduate Studies Office. Among graduate students, the least commonly used support structure was the Career Development Center (CDC). Women were more likely than men to use the Caltech Counseling Center, the CCID, the Caltech Y, and the CTLO.

Nearly 81% of undergraduates surveyed identified their peers as the primary source of support as they've progressed through their Caltech degree program. The second most identified primary source of support was family, which was selected by 4.4% of survey respondents. The

gap between the first and second choice is notable. We believe it speaks to the close-knit bonds that Caltech students have with one another. We also think that the extreme reliance on peers may indicate an unmet need, specifically with respect to our advising system beyond the first year. We plan on conducting multiple surveys, including surveying option representatives to learn how they assign advisors and surveying advisors to understand better how they understand their role. The 2019 Student-Faculty Conference considered this issue and made a series of recommendations, based on a student survey about advising, that we look forward to following up on. They made several suggestions, including establishing a team of two advisors per student. The first advisor would work to ensure that students take the required courses on time and with good progress, accounting for possible interruptions like study abroad, internships, etc. This one person would advise all students in the option. The second advisor would assist with “bigger picture” considerations, such as professional and personal interests, career options, graduate and professional study, research opportunities, etc. We believe that there is an opportunity to improve the advisor/advisee process and to clarify expectations for faculty and students.

Among undergraduates the most commonly used support structures were Caltech Libraries, Student-Faculty Programs, Student Health Services (other than counseling services), Caltech Athletics/Recreation, the Undergraduate Dean’s Office, the Career Development Center, and the Hixon Writing Center. An analysis of the undergraduate survey revealed that certain groups of support structures were often used in combination with one another. For example, use of the Hixon Writing Center was highly correlated with use of the Caltech Libraries and the CTLO. Interaction with the CCID was highly correlated with interactions with Caltech’s Equity and Title IX Office, the Caltech Counseling Center, and the Caltech Y. Interaction with Caltech’s Accessibility Services for Students (CASS) was associated with use of Caltech’s Occupational Therapy Services. Though these findings are correlational, they suggest specific student needs are

addressed by numerous offices and that partnerships across certain support structures may encourage student use.

The undergraduate survey asked students to indicate the extent to which they agreed or disagreed with the statement, “Caltech provides the academic and co-curricular support and resources needed for students to succeed.” Nearly 78% of survey respondents agreed with the statement (strongly agree or somewhat agree). Nearly 13% of respondents disagreed with the statement (strongly disagree or somewhat disagree). As additional support structures conduct in-depth assessments, we expect to learn more about why the percentage of student satisfaction with the support structures is not higher. With that data, we will work to improve that number.

Coordinated assessment, analyses, and narrative of data. The data assembled in the appendices that follow, and the accompanying SSWG cover document, are the result of SSWG’s intensive collaboration. The examination of Caltech’s academic and co-curricular support structures reveals an Institute committed to the academic success and personal well-being of our community. We see opportunities to improve, but with the data now housed in one place, we are well-positioned and eager to assess these structures on an ongoing basis.

Having conducted these surveys and assessments of the support structures, we believe that most of them are functioning very well, and the ones that have had challenges in the past are on the way to operating more effectively. Many offices have recently been reorganized and have new leadership, which signals a commitment to doing our best to help everyone at Caltech flourish.

COVID-19

On March 13, 2020, President Rosenbaum informed the community that spring quarter classes would be conducted online. By March 20, 2020, all undergraduates who were able to return to their homes had left Caltech, leaving fewer than 50 students on campus. The degree to which the support structures focused on in this report, as well as many others, came together has been

extraordinary. Housing and Dining Services ensured not only that the remaining students would live in the new Bechtel dorm where social distancing could be maintained, but also that the students would have access to a new food delivery system, Eat@home. The profound level of commitment demonstrated by every office on campus, whether in the provost's office, student affairs, the president's office, or human resources, cannot be overstated.

The support structures that comprise this TPR theme are no exception. All of them are fully operational and have been essential in translating a Caltech experience into a remote one, but one where students are connected, supported, and taught. The CTLO, in conjunction with IMSS, worked to ensure that all faculty had the training (often individually) to teach their courses remotely and to adopt Caltech's learning management system. Through webinars, division meetings, one-on-one consultations, and whatever faculty and TAs needed, the CTLO, Academic Media Technologies, and Information Management Systems and Services (IMSS) worked together to transition the curriculum to remote learning. We are assessing these activities by surveying the faculty, staff, and TAs who are teaching in the spring quarter.

SFP has continued its work. With the decision to close on-campus activities through August 31, 2020, the SFP had to determine whether summer undergraduate research could take place remotely. Every faculty member who had agreed to work with a SURF student was contacted, and 80% of these students will be conducting a ten-week research project remotely. Faculty were keen to make sure their students could do research over the summer, and many turned laboratory projects into computational ones. One professor developed a COVID-19 project using artificial intelligence to plot the likelihood and extent of outbreaks. Funded by the provost's office, this project will give eight students an opportunity to do summer research. The Caltech Center for Inclusion and Diversity has also taken the initiative to transform the Freshman Summer Institute (FSRI) into a remote program that maintains the rigorous math curriculum, research and mentoring components, and cohort-building experiences that define FSRI. Because we believe

that FSRI 2020 may be particularly important given the challenges related to COVID-19, we have expanded the program to 30 students.

Caltech's commitment to student success, and to assessing ways of ensuring it, has been crucial in helping students and faculty transition to remote learning. First, students were given the option to take each of their classes on Pass/Fail, regardless of previous requirements. Second, in the second week of the spring term, a survey was sent to [faculty](#), [students](#), and [TAs](#) with questions about our online platform (Moodle), technological challenges with remote learning, and open-ended questions about the teaching and learning experience. Data showed that collaboration was especially difficult for students and TAs who did not have whiteboards. Within 72 hours of getting this feedback, faculty worked with the ALO to initiate an iPad loaner program, funded by the provost and overseen by the library, which served as the implementation hub. 72 students received iPads. A [second survey on remote teaching and learning is currently being completed by faculty](#) and students in order to assess the iPad loaner program and to see if further interventions might be necessary in the event of continued remote teaching in the fall of 2020. Third, based on survey data, a committee of faculty and staff was established and recommended that Caltech switch Learning Management Systems from Moodle to Canvas. (CFR 3.5, 4.7) The transition to Canvas will be complete by fall 2020.

The coordinated efforts of the support structures have been essential in managing this crisis, and we look forward to assessing our efforts to find out what we have done right in response to this global emergency and what we can do better going forward in what we all hope will be less challenging times.

COMPONENT 9: REFLECTION AND PLANS FOR IMPROVEMENT

Caltech has learned a great deal from the TPR. What has emerged from the process is a community more educated in the importance of assessing students' experiences – both within the classroom and outside of it – and using the data to see how their experiences can be improved. We are better equipped to do this now having a set of refined measurable and specific learning outcomes for the Core, as well as a commonly shared set of objectives related to student support structures, against which to assess our effectiveness. Strengthening the Core learning outcomes for the Core Curriculum theme presented us with an opportunity to define not only the expectations we have for our students, but for ourselves. Are we doing everything we can to ensure that our students can achieve the academic goals we have set out for them? Are we providing them with the support structures that they need to flourish at Caltech and beyond? By and large, the answer is yes, but we still have work to do.

This work includes the following: 1) continuing the collaborative efforts that have engaged so many faculty in discussions of learning outcomes, assessment, student annotation, and curriculum maps. These activities have yielded a shared and more concrete understanding of what a Caltech education means, and therefore will become a routine feature of our assessment of the Core. They have also illuminated for faculty the importance of detailed syllabi, regular feedback, clear assignments, and course objectives. 2) examining and resolving a tension in the Core that, on the one hand, points towards the addition of a required class in computation, and on the other, maintaining the current number of required Core classes. Having established a revised set of Core learning outcomes, in relation to the Core Competencies, the institutional learning outcomes, and the degree program outcomes, we have clear benchmarks that will allow us to make a decision based on data. 3) continuing to support and assess the support structures that are crucial to the

academic and personal well-being of our community. This theme has shown the interdependence of these structures, with the in-depth assessments exemplifying their breadth and depth. Going forward, we expect that many more support structures will, on a rotating basis, undergo an in-depth assessment such as the six included in this report. This systematic exercise will allow us to continue our efforts to examine these structures more holistically. Advising is one of these structures. COFHE data from 2019 indicates that Caltech advising beyond the first year should be examined because students express dissatisfaction with their advising experiences. This joint project will be undertaken by offices in Student Affairs and the Provost, and evidence-based recommendations made in the [2019 Student-Faculty Conference](#), will inform our work

4) understanding better why students' self-confidence, especially during the first year of the Core and particularly among women, is shaken. We must continue to assess our pedagogical methods and our campus climate to find out why; 5) making data collected from assessment accessible. To accomplish this goal, we will develop a data dashboard to which the community will have regular and predictable access. In addition, a comprehensive campus climate survey is currently being developed and will be completed by constituencies across Caltech and the results will be made public.

As these reflections make clear, Caltech has changed and continues to change, and we are indebted to the TPR process for allowing us to see just how far we have come. To make sure that the momentum of this accreditation cycle does not wane, the Accreditation Steering Committee (ASC) has been made a standing Institute committee. The ASC will ensure that assessing our institutional effectiveness takes place on an ongoing basis to determine whether or not the desired outcomes developed by the CCWG and SSWG need to be revised, and to ensure that data collection remains a proactive enterprise. The TPR has given us an opportunity to reflect upon what a Caltech education means, and we believe that by strengthening our Core learning outcomes and studying our support structures, we have a better understanding of what that is.