University of Puerto Rico
Río Piedras Campus
Deanship of Graduate Studies and Research

Graduate Programs Evaluation Plan - Self-Study Report

College of Natural Sciences

Chemistry Graduate Program
M.S. and Ph.D. in Chemistry Programs

Evaluation period: AY 2015-2016 to AY 2019-2020

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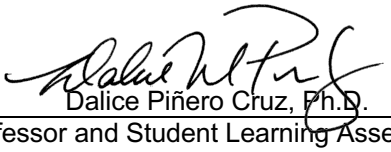

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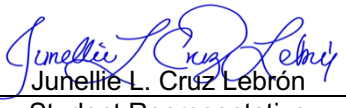

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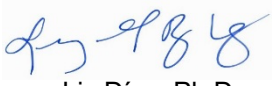

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Executive Summary

The Chemistry Graduate Program was established in 1961 offering a Master's degree and added a Ph.D. degree in 1970. Since then, it has awarded 199 Master's degrees and 299 Ph.D. degrees (4 M.S. and 36 Ph.D. in the last 5 years).

During this Self-Study the Program's main strengths were identified:

1. Preparation of professionals with deep knowledge and skills in chemistry – we have succeeded in preparing professionals who provide services of excellence in academia, industry, and government and therefore they have contributed to the socio-economic development of the country. Many of the Chemistry programs at other universities in the country have been nurtured by graduates of our program.

2. Scientific productivity of professors and students - as evidenced by the high number of research papers published in refereed journals (294 in the last 5 years) and the number of presentations by students and professors at conferences in Puerto Rico and abroad.

3. International recognition - as evidenced by the high number of international collaborations and awards that students and professors have obtained.

4. External research funding - Success in obtaining external funds is evident in the over $34 million obtained during the period covered by this Self-Study.

During the self-study we identified the main weaknesses of the Program:

1. Excessively long time to complete the degree due to too many credit and non-credit degree requirements. Most M.S. graduate students take 4 or more years to complete the degree, while for most Ph.D. students it takes seven years or more.

2. Slowness in creating new courses that are part of the regular curriculum - including special topics courses that have been taught for decades.

3. Travel funds, sabbaticals, and start-up funds for recruiting new faculty are not competitive, which endangers their recruitment and retention.

4. Low wages for students serving as teaching assistants are not competitive and endanger the recruitment and retention of the best students in the program.

5. Serious problems with infrastructure and safety in the Facundo Bueso Building.

6. Lack of a technology plan.

7. Lack of an operational budget of the program.

Recommended steps to overcome the situations encountered:

1. Curriculum revision of the Master’s and Ph.D. programs - This curriculum revision has already begun with the approval of a proposal for the revision of the M.S. and Ph.D. programs and the establishment of a new M.A. program that reduce the number of credits required to complete the degree. The proposal will be considered for approval by the Academic Senate on May 6, 2021.

2. Next 5-year Development Plan - This development plan, with the goals of recruiting professors and students, will establish the actions to be taken to ensure the attainment of the Mission, Goals, and Objectives of the program. Hopefully, contrary to the previous 5-year Development Plan, no student strikes, hurricanes, earthquake swarms, or pandemics will interfere with the implementation of the next 5-year development plan.

3. Achieving the allocation of an operational budget to the Program - Once we have the next 5-year development plan approved we can justify the need for an operational budget to achieve the goals set in the plan.

4. An aggressive plan of student and faculty recruitment. More online recruitment events will help reach a larger audience.

5. An orientation program during the first two years for students who enter the program, the establishment of a peer-mentoring program for new students, and yearly Individualized Development Plans for each student.

6. A peer-mentoring program for newly recruited professors.

7. Strengthen the management area with a full-time administrative assistant dedicated exclusively to our Program.

8. Constant assessment of student learning through the online learning assessment system (OLAS) so that it becomes a performance monitoring tool in the program and of quick action to detect faults and make improvements to it.

8. Establish an External Advisory Committee for the Program

We trust that all components of the Chemistry Graduate Program will work together to develop the program and advance the achievement of the Mission, Goals and Objectives.

Self-Study Report Narrative

I. Program Foundations

A. Background

1. Program Description - The Chemistry Graduate Program of the Río Piedras Campus of the University of Puerto Rico offers M.S. and Ph.D. in Chemistry degrees. The M.S. and Ph.D. programs were authorized and licensed by the Puerto Rico Higher Education Council ("Consejo de Educación Superior") in 1961 and 1970, respectively. The Chemistry Graduate Program has a Coordinator and is assigned an administrative assistant from the Office of Graduate Studies and Research at the Deanship of the College of Natural Sciences. The B.S. in Chemistry Program of our campus is accredited by the American Chemical Society (ACS), however, the ACS this does not accredit graduate programs. Therefore, our Program is not susceptible to receive accreditation from professional associations. Nonetheless, the Río Piedras Campus accreditation received from the Middle States Commission on Higher Education covers all graduate programs on campus. Alumni of our Program can exercise their profession immediately after receiving their degree, but to practice as a chemist in industry or government in Puerto Rico they must obtain a license granted by the Board of Examiners of Chemists of Puerto Rico, in addition to becoming a member of the Puerto Rico Chemists Association ("Colegio de Químicos de Puerto Rico"). However, chemists with a M.S. or Ph.D. degree do not have to take the examination of the Board of Examiners of Chemists. To work in academia in Puerto Rico there is no need to be licensed by the Board of Examiners of Chemists.

2. Nature of the Program -The Chemistry Graduate Program educates professionals with knowledge in the fundamentals of Chemistry as a discipline with emphasis in scientific research training and expanding and disseminating knowledge. The fundamentals of the main areas of Chemistry (Analytical, Biochemistry, Inorganic, Organic, and Physical Chemistry) are emphasized, while also enabling experience in emerging interdisciplinary branches such as materials science, bioinorganic chemistry, supramolecular chemistry, and nanotechnology, among others. The program continues to be successful in providing the much-needed college educators that teach the different areas of chemistry in all public and private higher education institutions on the island, as well as some in the Caribbean, Latin America, the United States, and other countries. The program promotes research and exchange of scientific knowledge locally and internationally.

Faculty is recruited based on a well-structured recruitment plan (see Appendix 1) that specifies the areas of the discipline where there is a need in the program. The applicant sends a recruitment package with a proposal of the areas of research that he/she will embark once hired. Therefore, the research interests of the professors dictate the research and creation done in the program. The program is committed to meet the needs, ideals and values of the Puerto Rican community responding to the need to train professionals with degrees in the chemistry field in the country to advance socio-economic development by developing high-level scientific research competitive with the rest of the world.

3. Program History and Accomplishments - The Chemistry Graduate Program was established in 1961 offering a Master's degree with a Ph.D. degree added in 1970. Its origin is a response to the need to train professionals with degrees in the chemistry field in the country. In addition, the expansion of the chemical-pharmaceutical industry in Puerto Rico necessitated a labor force trained in the chemical sciences. During its history

the program has awarded 199 Master's degrees and 299 Ph.D. degrees. During the 5-year period covered by this self-study, 4 master's degrees and 36 doctoral degrees were awarded. Alumni of the program are currently working in academia (47%), industry (47%), and government (7%) both in Puerto Rico and abroad, based on alumni that responded to our most recent alumni survey.

Among our highly successful alumni are professors at major universities abroad (e.g., Luis Echegoyen - University of Texas at El Paso (and former president of the ACS), Ángel Kaifer - University of Miami, Carlos Crespo - Case Western University and Angel Martí - Rice University) and others who have occupied or occupy high administrative positions in government, industry or academia (e.g., José Lasalde, former Vice President of Research UPR System, Pio Rechani, former director of the Institute of Forensic Sciences, Roberto Aguayo, former President of the Puerto Rico Chemists Association, Raul Castro, former director of the Department of Chemistry and former Dean of Academic Affairs at UPR-Cayey, John Colberg, former Senior director at Pfizer, Marilyn García Arriaga, TS/MS Representative at Eli Lilly and Company, Hilda Sola, Senior Scientist at the Center forTesting and Advanced Technology Division, National Vehicle and Fuel Emissions Laboratory, US Environmental Protection Agency, Ivelisse Colón, Pharm Sci Team Leader at Pfizer, Dionne Hernández, Project Manager for Kilopower at NASA's Glenn Research Center, Azlin Biaggi-Labiosa, Manager, Electric Aircraft Propulsion Subproject, Transformational Tools and Technologies Project at NASA Glenn Research Center, and Ingrid Montes, Director-at-Large of the American Chemical Society Board of Directors.

Several of our students have been successful in obtaining prestigious national and international fellowships such as the US National Science Foundation's Graduate Research Fellowship, NASA ASTAR Fellowship, and the Chateaubriand Fellowship of the government of France. The program maintains relationships with service centers and organizations such as the Materials Characterization Center (MCC), the University Industry Research Center, Inc. (INDUNIV), the Food and Drug Administration (FDA), the American Chemical Society (ACS), the International Union of Pure and Applied Chemistry (IUPAC), the National Science Foundation (NSF), the National Institutes of Health (NIH), the Department of Energy (DOE) and the National Aeronautics and Space Administration (NASA).

During the 5-year period covered by this self-study (Academic Years (AY) 2014-2015 to 2019-2020) professors have published a total of 294 papers for an average of 59 publications per year and the average number of publications per year among professors that published was 3. Professors in the program have registered four (4) patents and another two are pending, another three have provisional status, while an international invention disclosure has been accepted. The students and professors in the program have made a very high number of presentations at local, national and international scientific conferences.

The professors in the program maintain a high number of interdepartmental-, intercollege-, intercampus, and interuniversity projects, with universities in the country and abroad, as well as with industries, government agencies, and research institutes. In addition, program faculty are appointed to journal editorial boards of high international prestige and as critical reviewers of manuscripts in high impact peer-reviewed journals and of colleagues' proposals to federal and international agencies. There are professors who have been elected as "Fellow" of the American Chemical Society (ACS), the International Union of Pure and Applied Chemistry (IUPAC), the Royal Society of Chemistry (United Kingdom) and the American Association for the Advancement of Science (AAAS), and who have been members of the Board of Directors of the ACS, the Board of Directors of the AAAS, and Divisions of IUPAC.

The following number of proposals have been approved during the 5-year period covered by this self-study: ten (10) in 2015-2016, six (6) in 2016-2017, four (4) in 2017-2018, one (1) in 2018-2019, and six (6) in 2019-2020 for a total of $34,872,107.

In the five years covered by this Self-Study the program enrollment ranged from a maximum of 91 (AY 2019-2020) to a minimum of 79 students (AY 2016-2017). Out of 64 new students enrolled in the program during those years, 15 (23%) were international students. A recent decline in enrollment, reflects the decrease in the number of jobs due to the closure of pharmaceutical plants on the island in recent years.

As part of this Self-Study, we conducted a survey among current students, alumni, and professors in the program and in general they are satisfied with it. However, some students expressed their concerns that the program was not up-to-date, and some wrote that it did not prepare them with the skills needed in today's world and employment opportunities. Most respondents consider that the mission, goals, and objectives of the program, the curriculum, the research performed, and the faculty are excellent or good. Although graduate students are satisfied the available bibliographic resources, most alumni and faculty do not consider them excellent or good. In addition, only 22% of graduate students, 27% of alumni, and 14% of faculty consider that the physical facilities of the program are excellent or good. Furthermore, only 44% of graduate students, 40% of alumni, and 29% of faculty consider that the technology of the program is excellent or good. In addition, only 36% of graduate students, 53% of alumni, and 43% of faculty consider that the academic management of the program is excellent or good. Finally, regarding the number of requirements to complete the degree, most respondents believe that the number is too high.

The Chemistry Graduate Program responded to these survey results by developing a proposal to revise the current M.S. and Ph.D. programs and to establish a new M.A. program with no thesis, based on both the need to comply with the current campus *Policy on Graduate Studies and Research* (Certification #95, 2019-2020, of the Academic Senate) and the need to update our program to reflect the current educational and research trends observed in other successful Chemistry Programs. We examined the requirements of the Top Ten Chemistry Graduate Programs in the USA, as well as those of selected Chemistry Graduate Programs in the US that are comparable to our Chemistry Graduate Program in terms of publications, number of grants, and facilities. In addition, we took into consideration the recommendations of the 2013 report by a Presidential Commission of the American Chemical Society (ACS) on graduate education[1] for both the Master's and Ph.D. levels, on better preparing students for their careers after graduate school and focusing on educating students to solve problems in society, including the effective education of the succeeding generations. As a graduate program, we believe that scientific writing is one of the skills needed for successful professional careers and therefore implemented a course on Scientific Writing that in the revised program is going to be a required course.

The proposal to revise the current M.S. and Ph.D. programs and to establish a new M.A. program with no thesis has already been approved by the Department of Chemistry, the Academic Affairs Committee of the College of Natural Science, the Deanship Graduate Studies and Research of the College of Natural Sciences, the campus Council on Graduate Studies and Research, and the Academic Affairs Committee of the Academic Senate. This committee will recommend the approval of this proposal in the full Academic Senate meeting on May 6, 2021. We expect that the changes to our program will improve its overall quality in terms of graduation rate and productivity, as well as serve to better

[1] *Advancing Graduate Education in the Chemical Sciences: Summary Report of an ACS Presidential Commission.* American Chemical Society: Washington, DC, 2013, p. 4.

develop capabilities in our graduates to provide them sufficient preparation for their professional careers.

B. Vision, Mission, Goals, and Objectives; Need and Justification; Relevance of the Program

1. Vision, Mission, Goals and Objectives - Table 1.1.C shows the **Vision, Mission, Goals**, and **Objectives** of the Program and their alignment with the Strategic Plan of the Río Piedras Campus of the University of Puerto Rico. We aim to develop lifelong learning, creation, and dissemination of knowledge at national and international level and the training of professionals of chemistry that promote scientific, social, and economic development, to improve the quality of life in Puerto Rico, the Caribbean, and the world.

2. **Needs and Justification of the Program** - In this third decade of the 21st century, there is still a demand and a need to train and create the human and intellectual resources needed to make Puerto Rico an attractive place for increasing new fundamental knowledge, development of new technologies and enterprises with capable personnel, who have the capacity of adapting to the changing paradigm of science and technology entrepreneurship while promoting scientific, social, and economic development in Puerto Rico, the Caribbean, and the world.

3. **Relevance of the Program -** The characteristics that distinguish the program in comparison with others in Puerto Rico is that it is the only program on the island that offers a Ph.D. in Chemistry degree. In addition, the quality of the faculty on the program, their research fields of study are current, state-of-the-art, the number of publications, grants, and the opportunities for graduate students to participate in internships and collaborative research programs at world-renowned institutions (academic, government and industry), are unique on the island. There is a Ph.D. in Applied Chemistry program at the UPR-Mayagüez campus, but it has a different scope.

Our program has impacted other departments at UPR (e.g., Physics, Biochemistry and Pharmacy departments of the UPR-Medical Sciences Campus). In terms of the relation of the program with other programs and industries on the island and abroad, there is a research area related to crystallization and drug polymorphism that is conducted at the Crystallization Design Institute lead by Dr. Vilmalí López in collaboration with the pharmaceutical industry and Dr. Torsten Stelzer of the Pharmacy School of the Medical Sciences Campus. In addition, the X-day diffraction facilities created by two faculty members of our Program, Dr. Dalice Piñero and Dr. Vilmalí López, have been invited three times to offer continuing education courses to industry professionals of the Puerto Rico Chemists Association. Some of our research centers are in collaboration with other institutions, such as Cornell University and the Ana G. Méndez University in our NSF-PREM Center for Interfacial Electrochemistry for Energy Materials (CIE^{2}M). In addition, our NSF-CREST Center for Innovation, Research and Education in Environmental Nanotechnology (CIRE^{2}N), is in collaboration with the UPR-Cayey and Mayagüez campuses, the Ana G. Méndez University, Brookhaven National Laboratory, Los Alamos National Laboratory and the NSF Center for Sustainable Nanotechnology, a multi-institutional partnership aimed at developing a molecular-level understanding of the fundamental chemical and physical processes that govern the transformations and interactions of nanoparticles in the environment. The Puerto Rico Space Partnership for Research Innovation and Training (PR-SPRint) is a collaboration with NASA Ames and Glenn Research Centers. We are currently trying to be included in the NASA Kennedy Space Center's Growing Beyond Earth program, which is studying which plants and microalgae to grow in space. Recently, two professors in the program started collaborating with the EPA Addressing Environmental Concerns in Vieques, Puerto Rico Through Community Participatory Research Program with the Community-driven

assessment of environmental health risks in Vieques, Puerto Rico grant, led by the University of Massachusetts Boston and the Boston University School of Public Health.

In the 2020-2021 academic year we have 78 students (January 2021) enrolled in the program. In the last five years the number of enrolled students has stabilized. Since 2017-2018, there has been a reduction in the number of applications received in comparison to the base-year 2015-2016; a similar trend was observed in the number of students admitted. However, the incoming students rate ranged from 8 to 14 students. The total number of graduate students enrolled increased, albeit slightly, for the 2019-2020 academic year. Lastly, the number of degrees conferred remained relatively stable between 7 and 9 per academic year.

C. Profiles and Student Learning Objectives

1. Incoming student profile and Alumni profile - The incoming student profile is well aligned with the alumni profile. The course work, research training and the other academic exercises, such as seminars, proposals and workshops provide the student a well-rounded education. The Learning Objectives were designed considering the student's Entry and Exit Profiles and approved by the campus' Office of Student Learning Assessment. Students can demonstrate their progress throughout their studies by different evaluation exercises, such as those for Proposal A, Graduate Seminar, Proposal B and thesis defense. Being able to demonstrate mastery of the fundamental concepts of chemistry, application and integration of these concepts, wording in documents of research nature, among others, are the core of each of these exercises, where they can be evaluated by the thesis committee. Students complete the program and leave prepared for successful careers. According to the survey administered to alumni of the program, only 26% expressed dissatisfaction with the preparation it offered. In past years significant changes have occurred in the study areas of the program (by adding Special Topic courses in nanotechnology, supramolecular chemistry, bioinorganic chemistry, and biophysics, crystallography, among others) and major innovations have been proposed within the preparation of the Development Plan for the next five years. However, these innovations do not intend to radically change the profile of the incoming student, the learning objectives, and the alumni profile. We will continue to pursue a program of excellence in education and research.

2. Program Assessment Plan - The program uses its assessment plan and mechanisms to determine success in the accomplishment of the program's mission, goals, and objectives (institutional effectiveness). The Program prepares a survey administered to students, alumni, and professors of the program for each 5-year Self-Study Report. Based on the results of the previous Self-Study, the program engaged in a complete revision of the M.S. and Ph.D. programs and decided to propose the establishment of a new M.A. program in Chemistry with no thesis requirement. In addition, based on the results of the previous Self-Study, the program prepared a 5-year Development Plan. The program prepared a draft of a report of the implementation of the 5-year Development Plan, which detailed how the 2017 student strike and the Hurricanes Irma and María had negatively impacted the implementation of the 5-year Development Plan. More recently, the earthquakes' swarm that occurred starting in January 2020 and the still ongoing pandemic had further delayed the implementation of the Development Plan. As part of the current Self-Study, we will update the current 5-year Development Plan, which will consider the results of the new Self-Study Survey. The new 5-year Development Plan must be finished by September 2021. According to the Self Study Survey, 69% of the respondents think that the effectiveness of the program to accomplish its goals is high. In terms of the alumni profile, the results of the Self-Study Survey indicate that the students that graduate from the program are well-prepared to continue careers in the Chemistry field and fulfill the alumni profile. From the participants of the

survey, 42 out of 58 (72%) strongly agree or agree that the programs curriculum provides the skills and knowledge necessary to perform successfully in the world of work.

In terms of student recruitment, we have experienced a decrease in applications to the program. This decrease is related in part to the economic conditions on the Island since it has been in an economic crisis for the last decade and a half. The number of large and numerous pharmaceutical industry plants that used to be on the island have decreased as some of them had been moved abroad. In addition, the salary offer that we make to students accepted in the program is not competitive to the offers that they receive from programs in the US. The salaries for TAs in our program have not been raised for at **least two decades**. The salary from University funds to students recruited as teaching or research assistants is not competitive; currently it is $8,720 at the master's level and $10,900 (for ten months) at the doctoral level, which does not allow us to attract the best national and international students to the Program. According to a recent Glassdoor survey, the average base pay for a Teaching Assistant is $24,575/yr. ranging from $18K to $37K. (Glassdoor "Teacher Assistants Salaries Reports," accessed on 12/18/20, available at Glassdoor.com/research). In addition, the 2019 Graduate Program Survey Preliminary Results from the ACS Committee on Professional Training shows that the average teaching assistantship (TA) stipends in 2018-2019 were over $22,000/year. Of the nine (9) regions that the US territory was divided in terms of presenting the results, for the region with the lowest average TA stipend it was $22,313.00/year and for the region with the highest average TA stipend it was $30,237.00/year.[2] Knowing this, many of our best B.S. students pursue graduate studies in the US and many international students that we recruit to our program decline our offer and accept offers in the US.

In terms of student retention, the large number of requirements in the program has resulted in students taking a longer time than expected to complete their degree. Some students have abandoned plans to continue in the program or pursue a Ph.D. degree after completing a M.S. degree due to that aspect of the program. We are aiming to improve this situation with the revision of the M.S. and Ph.D. program that is underway. In addition, the problems with the infrastructure, equipment maintenance, purchasing delays, etc. do not encourage students to remain in the program upon completion of M.S. degrees. Nevertheless, the number of students that are being able to complete their Ph.D. degrees in a period of 6 years or less has either remain constant or increased.

The revision of the M.S. and Ph.D. program that is currently being reviewed by the Academic Senate includes the following curriculum changes:

1. The M.S. program credit requirement was reduced from 42 to 30 credits, whereas the Ph.D. program credit requirement was reduced from 75 to 59 credits for students that start the program with a B.S. degree. In addition, for students who enter the program with a M.S. degree, the Ph.D. program credit requirement is now 47 credits.
2. The qualifying exams have been eliminated for both the M.S. and Ph.D. programs. For the Ph.D. program they have been replaced with a Candidacy Exam.
3. A Scientific Writing course has been included as a requirement in both the M.S. and Ph.D. programs, to better prepare the students to write their Thesis Research Plans, Graduate Seminars, original proposals, research manuscripts, and theses.
4. Proposal B was replaced with an original proposal requirement, in which students work in the Scientific Writing Course with the first draft of this original proposal and then the next semester they improve the document before presenting and defending it as part of the Chemistry Graduate Program Seminar Series.

[2] ACS-CPT private communication.

The Student Learning Assessment Plan is based on the analysis of the current curriculum of the program. We are in the middle of the current three-year Student Learning Assessment Plan period. The current three-year assessment plan was improved with respect to the previous five-year assessment plan, which was too ambitious and made the gathering of data difficult. The current plan was the result of several very productive meetings between the Student Learning Assessment Committee and the campus Coordinator of Student Learning Assessment. In addition, the suggestions made were included in the new rubric for graduate student seminars.

As advised by the campus Coordinator of Student Learning Assessment, we started with a formative assessment. For the first year of the assessment plan, the learning domains measured were effective communication, discipline content, research and creation, and critical thinking. For the final two years of the plan, we added information skills and social responsibility learning domains. We decided to base the assessment of student learning on non-credit requirements, such as thesis proposal, graduate student seminar, original proposal, and thesis/dissertation. Therefore, no assessment integrated with the courses is currently in place. The current assessment is integrated with the activities to fulfill the non-credit requirements of the program.

A rubric is used for the assessment of the thesis research proposal, original proposal, and thesis presentation and defense. A separate rubric is used for the assessment of the graduate student seminar. At the beginning of each activity in which the student is being assessed, the faculty is reminded that they must complete the rubric and send it to the program coordinator to be used by the Student Learning Assessment Committee in the student assessment process. The benchmark to assess if the student masters the measured skill is if the student fulfills or completely fulfills the measured skill. For the program, it is based on whether 70% of the students fulfills or completely fulfills the measured skill for each assessment period. Based on the results of the first year, we were satisfied that the program had fulfilled the assessment evaluation metrics. We will consider if the level of fulfillment required should be raised to 80% of students satisfying the measured requirements.

The plan includes the use of the Online Learning Assessment System (OLAS) programming to gather the assessment data, but we are still in the process of migrating to OLAS. Our professors and TAs are being trained on using the OLAS system so that we can move to use it by the next assessment cycle. The plan includes informing about the results of the student learning assessment in meetings of the faculty of the Program. Two professors (the two faculty members of the Student Learning Assessment Committee of the program) and one graduate student representative collaborate in the implementation of the Student Learning Assessment plan.

There were unforeseen problems in the implementation of the assessment program. The administrative assistant that helped us with the assessment process retired. In addition, the current pandemic limited our access to campus to gather information from the students' files in the Office of Graduate Studies of the College of Natural Sciences. That made it very difficult to obtain the information needed to complete the first two years of the annual reports.

We have observed that the students' performance in research is highly correlated with the critical skills before starting to write their theses and with the design and implementation of the curriculum and program. The aftermath of: (a) Hurricanes Irma and Maria; (b) the recent earthquake swarm; and (c) the COVID-19 pandemic, all limited the number of students completing the non-credit requirements activities that are measured as part of the assessment plan. We are planning to use student interviews, focal groups, and joint discussions about the factors that can contribute or hinder the

achievement of the expected results.

II. Curriculum and Learning Experiences

A. Degree Programs

1. M.S. in Chemistry Program- The requirements of the current M.S. in Chemistry program are to approve 42 credits in courses (12 of them in graduate research), two Qualifying Exams, a thesis proposal (Proposal A), and a thesis. Although the course sequence allows a full-time student to finish in two years, most students take longer.

2. Ph.D. in Chemistry Program - The requirements of the current Ph.D. in Chemistry program are to approve 75 credits in courses (24 of them in graduate research), three Qualifying Exams, a dissertation proposal (Proposal A), a graduate seminar, an original research proposal (Proposal B), and a dissertation. Although the course sequence allows a full-time student to finish in four years, most students take longer.

3. Level of Satisfaction with the Degree Programs - The curriculum and learning experiences were evaluated through a survey that was answered by 57 participants, including three populations of the Program: current students (62% of the respondents, see Appendix 2), alumni (26% of the respondents, Appendix 3), and faculty (12% of the respondents, Appendix 4). Two main questions were asked at the beginning of the curriculum section of the survey to assess the level of satisfaction regarding the skills and knowledge necessary to perform successfully in their future careers, and whether the program provides them with the training to successfully complete the thesis and/or dissertation. 69% of the students currently in the program agree or strongly agree that the curriculum and the co-curricular experiences of the program provides them with the skills and knowledge necessary to perform successfully in their future careers; this value increases to 73% and 86% for the alumni and faculty populations, respectively. 67% of the students currently in the program agree or strongly agree that the curriculum and the co-curricular experiences of the program provides them with the training to successfully complete the thesis and/or dissertation; this value increases to 73% and 86% for the alumni and faculty populations, respectively. 72% of the students currently in the program say that the breadth and diversity of the curriculum and the co-curricular experiences of the program are good or excellent; this value changes to 60% and 100% for the alumni and faculty populations, respectively. 86% of the students currently in the program say that the level of depth in the specialty courses of the program is good or excellent; this value increases to 100% for the alumni and faculty populations. 73% of the students currently in the program say that the quality of training in the ethical aspects of the area of specialty of the program are good or excellent; this value increases to 73% and 86% for the alumni and faculty populations, respectively. 58% of the students currently in the program say that the quality of their experience as teaching assistants in the program is good or excellent; this value changes to 47% and 57% for the alumni and faculty populations, respectively.

In terms of the number of credits and requirements of the program, 47% of the alumni population believe it is satisfactory; this percentage drops to 36% among current students in the program and between faculty only 29% is satisfied with the number of courses' credits required. 69% of the students currently in the program say that the number of admission requirements of the program are good or excellent; this value changes to 67% and 86% for the alumni and faculty populations, respectively. 56% of the students currently in the program say that the frequency with which the required courses were offered is good or excellent; this value changes to 53% and 71% for the alumni and faculty populations, respectively. 86% of the students currently in the program say that the convenience of the courses' schedule is good or excellent; this value changes to 80%

and 57% for the alumni and faculty populations, respectively. 57% of students currently in the program say that they are satisfied with the qualifying exams as a measure of a student's ability to pursue graduate studies at Master's level or Ph.D. Among professors, 57% say the qualifying exams are necessary to develop critical thinking and the ability for independent study and research, while 60% of the alumni expressed to agree with this statement.

The proposed revision of the M.S. program and Ph.D. program reduces the number of credit and other requirements and should reduce the time-to-degree.

B. Courses and Learning Experience

1. Content and Curricular Revision - According to the alumni survey, only 7% expressed dissatisfaction with the preparation offered by the Program for success in their professional careers. Therefore, the external scientific community that evaluates and recruits them for jobs in industry, government or academia understand that the curricular content of our Program is a solid one that prepares our alumni satisfactorily. The curricular content received external peer-review as part of the previous Self-Study of the program. The content partially reflects ethical, legal, and regulatory normatives and standards that impact this field of study, since according to the alumni survey, 73% of them express that the quality of the ethical training in the curriculum is satisfactory or very satisfactory. The curriculum has been adequate for accomplishing the development of the competencies included in the alumni profile. According to the alumni survey, the diversity of the areas in which our alumni currently work give evidence that the amplitude, depth, and the level of the curriculum is adequate. In addition, the interdisciplinarity of the research that our students are involved with provide them with the amplitude and depth to prepare them for their future careers.

The last curricular revision contributed to make students get involved in research earlier in their graduate career through the Proposal A (thesis proposal) requirement and to initiate them into bibliographic search in the scientific literature. The Proposal A requirement is named now the Research Plan Proposal in the proposed revision of the Program. Since 2016, a formal rotation process was established for new graduate students that counts for one credit for research done during their exploration period in the host laboratories. However, in the new proposal for revision of our Program, the rotations continue, but on a voluntary basis. In addition, a Scientific Writing course that has been offered for the last two years as a Special Topics course will become an official requirement of the program. At the M.S. and M.A. level, the revision includes that no qualifying exam or candidacy exam will be required, and at the Ph.D. level the current qualifying exam requirement is replaced with a candidacy exam. Finally, the current Proposal B requirement (original proposal) will be replaced with an original research proposal for which the student will write the first draft of the document as part of the Scientific Writing course under the supervision of the course professor, and then during the next semester the student will finish the final version of the document to present and defend it as part of the Graduate Seminar Series. The new revision includes the changes required to renew the curriculum.

The program has been very effective in imparting knowledge and skills through its curriculum as evidenced by the Self-Study survey. 69% of the student who answered the survey agree or strongly agree that the curriculum provided the knowledge and skills required for the discipline. In addition, 67% of the student who answered the survey agree or strongly agree that the curriculum provides the training to complete the thesis, dissertation, or related project.

The complementary activities that have been conducted to strengthen the program curriculum include professional development workshops that have been carried out as part of the Graduate Seminar Series and that special topic courses have been updated to cover emerging areas in the discipline. On the other hand, the Graduate Association of Chemistry, in its self-management to complement the program, has carried out activities outside the classroom that directly strengthen the curriculum, such as visits to pharmaceutical and biotechnology plants. The association has also conducted peer mentoring services among its members.

2. Admission Requirements- The admission requirements are the usual ones for chemistry graduate programs in the US. We do conditional admissions if the student has not submitted all the documents required for admission and if they have an academic index slightly below the required one, but their other documents show a high probability that the student will be successful. We have recently identified that some incoming students have some basic knowledge gaps. The program plans to offer more mentoring services (both from faculty and fellow advanced graduate students) to entering students to help them adapt to the level of requirement of the program. Most of the students enrolled are prepared to meet the requirements of the program judging by the retention and graduation data. Few students (less than 10%) fall into probation each year. Although most of the students admitted to the program have a B.S. in Chemistry degree, students do not need to have a bachelor's degree in Chemistry to be admitted but must have completed the required undergraduate courses.

Although the initial courses are the core courses in chemistry, the professors make efforts to bring the group to the required level, irrespective of their institutional background. This may include some reviews of material, tutoring by professors, and even workshops. Since our core courses are taken by all entering graduate students during their first year in the program, they have no impact on their time-to-degree.

3. Graduation Requirements - The graduation requirements are aligned with general learning objectives and facilitate their achievement. The program is designed for students to have an experience attached to a research laboratory and cannot be provided by a professional experience or an equivalent job. However, in the recently conducted revision of the program the students can substitute some requirement credits with internship experiences in external laboratories. The program offers the option to enter directly to the Ph.D. program without completing a M.S. The guidelines for all degree requirements approved by the faculty of the Program, are included in the regulations document given to all entering students.

4. Curriculum Design Analysis - Although currently the program only has a full-time curricular sequence, the proposal for revision of the program includes a full-time and a part-time curricular sequence to meet the needs of the students. In terms of the approval of courses, students meet the stipulated time to meet those requirements, but some non-credit requirements such as Proposal B has lengthened that time. The proposed revision should reduce the time-to-degree.

The sequence of courses is distributed with core courses in the first year, which are requirements for specialty courses, that are taken starting their second year in the program. The core courses are the same for M.S. and Ph.D. students and have the appropriate level of complexity. This is because graduate students in both the M.S. and Ph.D. levels must have the same basic knowledge. It is understood that students enter with substantial fundamental knowledge. Specialty courses built on the knowledge and skills acquired in the core courses and contain a heterogeneous distribution of essential knowledge of the discipline. The Special Topic courses which are offered as advanced courses and electives contribute to the content of the specialty.

Some of them are so vital that are being considered to become part of the regular curriculum of the program. Special Topics courses usually have as requirement the development of a research proposal or a publication in a peer-reviewed journal, which promote productivity and creative professional work that contributes to the development of the discipline of study. One of the requirements of the curriculum is for students to present their research results at conferences and publish them in refereed journals, also contributing to the development of their discipline. Their participation in scientific conferences exposes and develops in them knowledge and interdisciplinary learning. Proposal B stimulates creativity in the development of a distinct solution to a research problem.

Most of the students are prepared to meet the Program requirements judging by the retention and graduation data. This implies an adequate relationship between admission requirements and degree requirements conducive to a satisfactory performance in the program. The implementation of the next development plan will help students to plan their curriculum with at least two years in advance. The Program recently approved the designation of two professors as graduate academic counselors to help student better organize and meet degree requirements.

The next 5-year development plan and curriculum review seeks to cross boundaries of disciplines in all areas of science. The curriculum and learning experiences attend information skills and knowledge of the latest technology in the discipline. The Library of the College of Natural Sciences offers information skills workshops that promote the development of skills in search and information management. Graduate seminars allow students to select and synthesize the information gathered. Students take a workshop on ethics in the guidance and training activity that all new students take before starting their first semester in the program. The workshops on safety and waste management also allow students to develop social and civic awareness. Many of the research projects in the program attend current social problems.

The curriculum provides students with the necessary knowledge and laboratory skills necessary to succeed in the professional careers. However, the current curriculum does not provide students a formal internship course. Nevertheless, many of the research programs offer students the opportunity of internship experiences in national research laboratories and in academic laboratories abroad.

C. Academic Offer

1. Courses that make up the curriculum- The general course syllabi are kept up to date and comply with the requirements of Certification 42 (2019-2020) of the UPR Governing Board. The content of the courses has maintained the expected tangency with the alumni profile. The current pandemic forced the program to conduct all courses online. We have not created new online courses, just modified the current in-person courses to give them online. Now that professors have had the experience of offering online courses and received training on preparing them, we expect the creation and modification of some graduate courses into hybrid, distance, and online modalities.

2. Course offer - At the 6000 level, courses are offered every semester, whereas at the 8000 level, usually in alternate years. 56% of the current students and 53% of the alumni that answered the Self-Study survey believe that the frequency of the required courses is either excellent or good. All the courses in the sequence are offered regularly, but some Special Topics courses have not been offered with the same frequency, some due to recent faculty retirements. The required courses and electives are offered according to the curricular sequence. We have enough core courses and specialized courses to fulfill our student body needs.

Students from the Chemical Physics graduate program regularly take our Physical Chemistry courses. In addition, students in the Environmental Sciences graduate program take some of our courses. There is still no Program-wide procedure for the evaluation of all courses by students, but the survey conducted as part of this Self-Study included a question about this matter. The next development plan includes that all divisions in the Program will embark in an evaluation of their courses, which will include course evaluations by student.

III. Professors/Researchers

A. Programs Professor's Profile - Twenty-one (21) professors (5 female) were giving courses in the Program during the years covered by this Self-Study; 17 from Puerto Rico, one from Brazil, one from China, one from Peru, and one from Germany. Thirteen (13) obtained their Ph.D. degrees in the US, six in Puerto Rico, and two in Germany. The professors profile responds to the needs and aspirations of the Program in terms of specialization, internationalization, and development of research work since professors are recruited using the department recruitment plan. Most of the professors of the department have research in transdisciplinary areas.

During the past 5 years most of the professors devote 42% (5 credits) of their effort to teaching and 58% (7 credits) to research. The distribution of the academic load of the program professors is not adequate to promote their productivity and performance in teaching and research, since in the last two years some of the professors have had to take additional teaching duties, because a considerable number of professors have retired, and the administration have not provided the resources to hire new professors. In addition, during the last two years the administration has required additional reports and information, that have increased the responsibilities of the professor limiting the amount of time that is available to research.

B. Research and Creative Work Projects - For the reported 5-year period 27 research proposals were approved for a total of $34,872,107. There is a complete alignment between the research carried out by the professors in the program and their research lines presented in Table 3.1A, but some professors have recently added new research lines. Among the new research lines that have been added are nuclear energy, COVID-19 sensors, bone regeneration, all added due to significant innovation in research areas. All research being conducted in the program is done by graduate and undergraduate students and impact their thesis and dissertation research work.

Our research centers (CIREN, CIE2M, PR-SPRINT, Center for Advancement of Wearable Technologies CAWT) contribute significantly to the student research and the completion of their thesis and dissertation research work since students carry them out within those centers. These centers provide students with stipends, materials funds, access to instrumentation and technology, internship and networking opportunities with external collaborators, professional development, and technical workshops, among other educational and professional opportunities. A large majority of the professors in the program are members of several of these research centers. All our research centers offer student summer research camps, and the Program is involved in the Department of Chemistry active ACS Project Seed program. In addition, several of these centers and the ACS Student Chapter visit communities and public schools and offer after-school programs, citizen science workshops, and chemistry shows. Furthermore, we offer advice to students involved in Science Fairs and serve as judges.

One of our recently retired professors, Dr. Osvaldo Rosario, has been involved as environmental consultant of many community-based organizations and was honored by the AAAS-Caribbean Division for his contributions in these endeavors. Prof. Jorge Colón

has been involved with the community of Vieques, Puerto Rico for many years and recently published a chapter that mentions some of those efforts in the book on the 25th Anniversary of the UNESCO Chair on Peace Education in our Río Piedras Campus. The faculty currently collaborate with peers on Campus (from the Departments of Biology and Environmental Science, the College of Business Administration, and the College of General Studies), other institutions in Puerto Rico (UPR Medical Sciences Campus, and the Mayagüez and Humacao Campuses, the Interamerican University, the Ana G. Méndez University, and the Pontifical Catholic University of Puerto Rico), other institutions outside of Puerto Rico (for example, in the US: Cornell University, Stanford University, University of Texas at El Paso, and Brookhaven National Laboratory), and other institutions outside of Puerto Rico and the US, such as the University of Nantes, France and the Universidad de Alicante, Spain.

C. Funds - The amount of funds available through the Deanship of Graduate Studies and Research for teaching assistantships have been limited in the past few years. Other than the FIPI program (a competitive in-house small research grant program) there are no other incentives provided by the Program, the College and the Campus used by professors and students for research. The number of teaching assistantships and research assistantships is not sufficient to satisfy the needs of the Program. In addition, the salary that students receive in the campus assistantships is way too low. Many students must take jobs outside campus, limiting their time to focus on their research. The budget granted to the Department is limited and barely enough to cover the costs of the expenses of the courses of the academic offer at the undergraduate level. During the last five years, $5,000 dollars have been set aside for the Chemistry Graduate Seminars. Professors do raise sufficient funds from competitive grants to finance their research.

D. Student Research - The data in Table 3.5.E (Appendix 5) reflects that the student research has been maintained at a high level throughout the years. Students have been successful in obtaining fellowships (Deanship of Graduate Studies and Research Fellowships, NSF Graduate Research Fellowships, Chateaubriand Fellowships, among others). A recent graduate of our Program received the 2021 Young Investigator Award for his Ph.D. research from the Division of Inorganic Chemistry of the American Chemical Society. We need to identify new sources of funds to allow us to (partially) cover travel expenses for student making presentations in local, national, and international conferences. A newsletter of the Department of Chemistry would allow us to disseminate opportunities for students willing to disseminate their research.

Around 35% of the undergraduate students majoring in Chemistry are enrolled in the QUIM4999 undergraduate research course with by professors in the Program. To increase the participation of undergraduate students in our research projects, we plan to carry out more Open Houses, research seminars aimed at undergraduate students, and visit undergraduate courses in other institutions to talk directly to Chemistry students.

F. Publications- Table 3.6.F in Appendix 6 shows the publications of our faculty in the past five years. The Program expects each professor to publish at least 3 publications per year. Even with the hurricanes, earthquakes and pandemia, the faculty has maintained high levels of productivity in research work. Professors in the program are highly motivated to continue their research progress and have exceeded expectations in terms of research publications and presentations. The competitiveness and projection of the Program has been increasing steadily thanks to the impact of the publications and presentations of our faculty and students.

IV. Students/Alumni

A. Threshold of the Program - The program has a threshold of admitting each year

up to 30 students in the program, based on the schedule of courses, number of active students currently in the program, budget, quantity of courses to be taught, quantity of professors available to teach courses, number of active researchers available to supervise theses, dissertations, and degree projects, and facilities. On average, the number of applicants and admissions has been below the threshold. There has been no need to adjust admissions due to the threshold since we have never surpassed it. The number of new students enrolled is less than the one projected

B. Recruitment - Among the recruitment strategies are graduate studies fairs, promotions on UPR and Department web pages and social media, and visits to other universities. We are successful in attracting and recruiting a diverse and qualified student population, but if our stipends for students were higher, approaching what is offered in other comparable programs in the US, we could attract and recruit many more.

C. **Student Population -** The percentage of selectivity of the program on average is 50% for male students and 50% on average for female students. The average attraction percent is 68% for male students and 73% for female students, which we consider satisfactory. The demand and the number of students admitted to the program has diminished during the last 5 years. External factors that have affected student recruitment in the period covered by this Self-Study, such as a student strike in the second semester of the 2016-2017 academic year, and the hurricanes Irma and Maria in the first semester of the 2017-2018 academic year. In addition, the economic crisis on the island has increased migration to the United States, diminishing the pool of students targeted for recruitment. Finally, immigration policies during the Trump administration were detrimental for the influx of new international students.

D. **International Students -** The student body of the Program is very diverse, including students from Latin America, the Caribbean, Asia, and Africa. We have admitted an average of five international students per year to our program (11 in 2015-2016, 9 in 2016-2017, 2 in 2017-2018, 6 in 2018-2019, and 3 in 2019-2020). Learning from other cultures takes place spontaneously when the integration of students with different cultural backgrounds is achieved, which has been one of the successes of the program. Bringing students from other cultures who have commitments, lifestyles, study methods and teaching approaches different from ours increases the competitiveness of the program since students contribute to their courses both in the construction of ideas and in the formulation and the analysis of scientific questions in various ways. Therefore, the program's students can enrich their analytical skills, increase their vision of what other programs in other countries provide, and become familiar with the reality of social problems facing other regions of the world.

The commitment of the Program to provide degrees of higher education to our neighboring countries in the Caribbean led to the establishment of a MOU with the State University of Haiti and our Campus. The first Haitian student graduated from the program in 2020, another one should graduate in 2021 and a third one in 2022. One of our faculty members, Dr. Zhongfang Chen, who is originally from China, has been successful recruiting students from China to our program; over eight (8) students from China have joined our program since the previous self-study. The program also has students from Chile, Colombia, Venezuela, Peru, among other countries.

E. Student Retention - Some students have not completed the Program in the past few years, due to voluntary withdrawal, or to health difficulties, or to difficulties with interpersonal relations with the faculty, and some due to a mismatch in the expectations of the mentor-student research work plan. From the information gathered it has been noticed that the pandemic situation that forced all education, at all levels, to move to online education, put time restraints to students who are heads of their family, as they

must help their children manage online learning. When the coordinator learns about a student who is considering withdrawing from the program, options are presented to the students, meetings are held to better understand the situations that the student is having and discuss ways to help them. The program has approved this semester to assign two professors as academic advisors and they will further assist these students.

F. **Economic Incentives -** The Program has consistently voiced their concerns with the administration that the stipends for graduate students must be increased, or otherwise we will not be able to recruit and maintain students.

G. **Graduation -** The Regulations of the Program specify a suggested curricular sequence which if followed a student would complete the Ph.D. program in 5 or 6 years. The Program conducts an annual orientation with entering students in which the importance of following the curricular sequence is emphasized. The graduation rate (around 7 degrees per year) compares favorably with the projected one. The revision of the M.S. and Ph.D. program should reduce the time-to-degree and increase this number.

H. Alumni- We send a survey to alumni every 5 years as part of the Self-Study of the program and maintain contact with them through e-mail and social media. We have a list of all alumni from the program which we try to keep updated. The alumni of the program are employed in academia, industry, and government. Some examples are Eli Lilly Pharma, Boston College, Brooklyn College, Louisiana State University, University of Puerto Rico, and University of Bristol (England). Alumni can obtain employment within six months of graduation. 40% of alumni continue more advanced studies. Professors in the program motivate, advice and help students to pursue more advanced studies. In addition, research experiences undertaken by our students at other universities or research institutions provide role modeling examples that build postdoctoral positions aspirations. The data and information of the alumni has been used to design the revision of the Program, both at the M.S. and Ph.D. level.

V. Resources and Essential Services for Teaching, Research, and Creation

A. Services and Support Personnel - According to the survey administered to students and professors 71% were satisfied or highly satisfied with the support services offered by the administrative personnel of the department from 2015 to June 2020. But the current capabilities and number of available support staff is not enough to respond to the demand and identified needs of students in the program. The Program doesn't have any assigned full-time administrative assistant. Due to the retirement of the previous program administrative assistant in June 2020 some of the support services offered have been affected and delayed. Ever since our full-time assigned administrative assistant was moved to the Office of Graduate Studies and Research, we lost this support. The currently assigned administrative assistant is also in charge of several other graduate programs. We have informed the Dean about the need for a full-time administrative assistant for our Program, but have been informed that there is no budget available.

B. **Learning Resources and Information -** The major investment in bibliographic and informatics resources in the past few years have been related to SciFinder and online journals from the American Chemical Society. The ACS Sci-Finder license allows faculty and students to access and obtain full versions of publications in all ACS journals. The SciFinder subscription has a cost of $35,000 per academic year. Recent budget cuts have limited our capabilities in terms of access to non-ACS research journals and published data. As more journals enter the Open Access format, some of these difficulties might be reduced. In addition, some specialized software libraries such the Cambridge Crystallography database, has been acquired annually for a cost of $3,600. Professors use Moodle, Google Meet, Zoom, and Google Drive, among other technology

to offer their courses. Professors who do computational chemistry, such as Professor Zhongfang Chen, and crystallography, such as Professor Dalice Piñero, make use of computers and programming exclusively dedicated to these research projects. There are computers and programs exclusively for scientific instrumentation, some for shared use.

Publications that are required in some courses, where students make use of the available electronic sources of research publications in journals to complete the course requirement of publishing a peer-reviewed manuscript, is evidence that the faculty and students accessed and used information in various formats, including electronic sources of information. The student survey and the presentations and papers published by students demonstrate the available information and learning resources were effective in achieving the mission and goals of the Program. The COVID-19 pandemic forced all courses to be online and faculty and student had to adapt to improve computers and computer literacy skills to complete courses and continue research. Today's research requires many technological and computational skills all the way from Microsoft Word to Gaussian 16. The recent revision of the M.S. and Ph.D. programs and its assessment of student learning which are now done every semester will help the program better access the effectiveness of the integration of learning and information resources.

C. **Technology Plan -** The program currently does not have a Core Technology Plan. However, the research labs are totally proficient and up-to-date in the required technology to further their research interests. The Program does not have computers other than those owned by the Program Administrative Assistant. However, the research laboratories have adequate laptop and desktop computers resources to fulfill the students and lab personnel needs.

The administrative assistant assigned to the Program is assigned a desktop computer. If we use that number to calculate the ratio of students per computer, it would give a number of 79 for AY 2019-2020. But the reality is that students, if they do not have a laptop, use the computers that professors of the program have in their laboratories. The College of Natural Sciences through its Library makes available laptops computers to graduate students, including the ones in our program. More computer programs suitable for user demand are needed if each one was to be used individually. However, the campus-wide access to the MS Office 365 application through the University portal makes it possible to use these applications for free, thus providing access to all students.

The facilities used by students and professors, apart from what each professor has in his/her research laboratory, consist mainly of what "Center for Information and Technology (CITEC for its acronym in Spanish) provides in the Néstor Rodríguez Rivera Library in the College of Natural Sciences. These facilities are consistent with the needs of users in terms of offering workshops on using MS Office programming, on creating bibliographic files, on the use of EndNote Web and on scholarly communication, among others. CITEC has the list of trainings available at http://www.bcn.uprrp.edu/literacy/courses_spanish.html.

The use of technology is limited by the lack of constant access to the Internet. Access to Ethernet cables is very limited in the Facundo Bueso Building, where most of the Program's professors, students, and laboratories offices are located. On the other hand, the Wi-Fi signal on Campus, although improved for the condition five year ago, sometimes is sporadic and inconsistent. It is necessary to improve this access to the Internet in the building to take full advantage of this tool.

D. **Facilities, Laboratories, and Equipment for Teaching -** Five years ago, we mentioned in the Self-Study that the program has adequate number of laboratories, equipment, instruments, and auxiliary resources for teaching, but that it only has available

under its control one teaching classroom. The situation remains the same. Through the research grants that have been approved for the establishment of research centers we have been able to update facilities, laboratories, and auxiliary equipment to meet the advances in the program and in the discipline. The facilities in the Facundo Bueso building suffer from being in an old building that makes somewhat difficult to maintain an optimal environment. In addition, the budget cuts have prolonged the time needed to make renovations to the facilities.

VI. Management, Planning, and Development

A. Operation of the Program

1. **Management -** Of the respondents of the Self-Study survey, 60% perceived the management of the Program as an agent of change. In a recent survey to students and professors on management, 24 of 58 (41%) of respondents said that they are satisfied with the academic management. The Program aims to provide an excellent service in all areas to students, alumni, and professors, however, currently we have not been able to do that in a satisfactory way. Much improvement is needed, as evidenced by these responses. The biggest challenges are the lack of trained personnel to support faculty and students, and the lack of budget to cover program expenses. The Department has requested to hire an administrative assistant to cover the positions left open when Mrs. Wilma Santiago and Mrs. Aida Arce retired. None of those two positions have been filled. In addition, important decisions on physical facilities, materials and supplies are taken at higher administrative levels, limiting our ability to solve problems related to these issues.

Meetings with students in the program have been performed to ask them about their needs. Student counseling needs improvement. The program lacks tools to prepare students in the workforce outside of technical literacy (i.e., management, inventory, budgeting, teamwork, etc.). Based on the responses to the Self-Study survey, there are several service areas that requires special attention. Among them are: 1. Improved student counseling on the program requirements and interpretation of the program regulations (bylaws); 2. Better and more constant communication with students in all aspects of the program, including requirements and administrative processes; 3. Administrative procedure and paperwork related to TA contracts and their approval.

The improve the quality of the program in terms of the academic management we need to have better administrative support, particularly with at least a full-time administrative assistant assigned to the program. We used to have such a position assigned to the program, but due to fiscal constraints, that person was assigned to work with several other graduate programs, reducing the services and the assistance to our students, alumni, and professors. Among those are delays in important processes such as enrollment and contract preparation for students' stipends, which are among the main complaints of the students.

In addition, a formal process of counseling between students and the Coordinator must be implemented, where the student presents his/her Individualized Development Plan (prepared with their graduate research mentor) and fills a draft of the Academic Status Sheet that is given to the new graduate student upon entering the program as part of the program regulations document. The Academic Status Sheet allows the student to understand how many requirements he/her has completed and how many remain.

Budget constraints that do not allow us to offer the students a student meeting area with the minimal facilities (tables, computers, printers, seating area, board, coffee area, etc.). In numerous occasions we have communicated with upper administration officials to obtain support for initiatives to better meet the needs and aspirations of the Program, only

to be ignored. We have not felt support from the upper administration to our efforts to help in the development of our program. Among the policies or procedures related to university senior management that should be modified to facilitate the operation and development of the Program are:

1. To allow the graduate programs more autonomy to be able to manage all student TA/RA contracts in our Department.
2. More control of the Department of Chemistry budget
3. Faster administrative procedures such as purchasing and infrastructure repairs.
4. Attention to the following OSHA regulations (occupational laboratory safety, fume hoods, pest control, water leakages, black molds, air conditioners maintenance and repairs, electrical system maintenance and repairs).

2. **Administrative Personnel -** In the past, our program had a full-time administrative assistant. Later, this person was moved to the Office of Graduate Studies at the Deanship of the College of Natural Sciences and she must assist other graduate programs. The administrative assistant that we had for the last 20 years retired in summer of 2020; currently we don't have a full-time administrative assistant assigned exclusively to our program. The Program has the full support of the Office of the Director of the Department. However, at higher administrative levels, we lack full support, in some cases due to upper management decisions. Many times, we receive important information about fellowship opportunities for our students too late to help them apply to the program. The situation with the student enrollment process has caused many students who have enrolled to be taken out of the enrollment system and we must enroll them again. There is no formal evaluation system for administrative personnel. Only when the administrative personnel are asking for a promotion, a formal evaluation is done by their supervisors. The Coordinator of the program doesn't participate in this process, since he doesn't supervise the administrative assistant assigned to our program.

The faculty of Program meets regularly to discuss and take decisions regarding all aspects of the program. The former administrative assistant participated in all these meetings, but the current one had not assisted yet since this person says that is not part of her assigned tasks. Two student representatives are elected by the graduate student body and participate in all meetings, as well as in the Program committees. Therefore, faculty and students have broad participation in decision making in the program.

The Admissions Committee members accepted to also be members of the Graduate Affairs Committee, since matters dealing with graduate students are better deal with by the faculty members that have known the students since they applied to the program. The Student Learning Assessment Committee stopped working right after Hurricane María and was not able to continue the assessment process until one year later.

3. **Faculty -** The University Administration has not honored, even partially, our recruitment plan.

To maintain the Department's productivity on publications and approved grants, the recruitment plan seeks to replace retired and leaving faculty. The newly recruited professors also help meet the teaching needs of the undergraduate program. The Department of Chemistry and especially the Graduate Program has experienced a significant decrease in its roster of research professors. Due to retirement, we lost professors Rafael Arce (physical chemistry), John Soderquist (organic chemistry), Osvaldo Rosario (analytical chemistry) and José Prieto (organic chemistry). We also lost Professor Reginald Morales due to unexpected death and professor Pascuale Fulvio (physical chemistry) due to resignation.

To maintain the Department's productivity in publications and approved grants, the current Recruitment Plan (2019) seeks to replace these researchers, to the extent possible. The new recruits will help meet both the research and teaching needs of the Graduate Program, as well as the Undergraduate Program. This Recruitment Plan includes an already approved position for an analytical chemist that was announced last summer (2020). This opening corresponds to an institutional commitment with the 5-million-dollar grant recently awarded by NSF-CREST (National Science Foundation-Centers of Research Excellence in Science and Technology) to Dr. Carlos Cabrera, a Professor of the Department of Chemistry. This position is still open and continues to receive applications. On the other hand, the Department is requesting six (6) new faculty positions. These are two (2) in chemical education, two (2) in organic chemistry, one (1) in biochemistry and one (1) in physical chemistry. It should be noted that these positions have now been requested, but that they have not been approved yet by the Institution.

The biggest problem the Program faces when it comes to recruiting research faculty is not being competitive in either the salary or the seed fund package or the salary of graduate students, all of whom are far below of the norm in institutions with a “ranking” like ours. Travel funds, sabbatical leave, and seed funds for the recruitment of new faculty are limited and informally administered. These funds in the best of cases are not competitive when compared with the graduate programs whose classification we aspire to achieve. According to a recent Burroughs Wellcome Fund survey institutional offers of start-up support (excluding salary) for Ph.D.s averaged $800,000 (range $500,000 to $1,400,000), with a median of $750,000. The initial offer in seed funds includes for two-three years period salary of a postdoctoral student, including benefits, salary for two graduate students, salary for the professor for the two summer months, funds for trips to participate in annual meetings and funds for instrumentation and materials according to the researcher's area of research and needs (Glassdoor “Salaries and benefit Reports,” accessed on 12/18/20). Available at Glassdoor.com/research). The recruitment priorities for the next five years are to recruit at least on new tenure-track assistant professor in the areas of Organic Chemistry, Physical Chemistry and Biochemistry. We have recently recruited a new Assistant Professor in Analytical Chemistry that will start in a tenure-track position in August 2021.

On the other hand, as stated before, the salary offered to students recruited as teaching or research assistants is not competitive.

4. **Permanent Committees -** The Program's permanent committees are the Admissions Committee, the Graduate Affairs Committee, the Graduate Academic Affairs Committee, and the Assessment of Student Learning Committee. Every committee works efficiently and fulfills the tasks proposed annually. The Academic Affairs Committee and the Assessment of Student Learning Committee have developed new initiatives, including the proposal for a new M.A. Chemistry Program and the revision of the M.S. and Ph.D. programs. In addition, they have worked on a curriculum revision. The Chemistry Graduate Program does not have an external review committee, but our 5-year Development Plan will include the establishment of an External Advisory Committee.

B. Community Relationships - As part of the revision of the graduate program, students will be provided with an alternative to perform internships or practices instead of being a research assistant. These internships or practices can be completed at non-profit organizations or government agencies that serve communities. With this curricular change our students can contribute to attend community’s needs. All research proposals submitted by our faculty include an outreach and educational component to link our research and program to the community. In addition, existing research initiatives have interventions with communities and public schools, including the NASA PR-SPRInT, NSF-CREST CIRE^{2}N and NSF-PREM CIE^{2}M research programs.

There are some collaborative agreements (MOU) that vinculated our Department, or some researchers with the private sector. There an MOU between the UPR X-ray Diffraction Facility, created by two our faculty members, and the Materials Characterization Center (MCC) that enables services to the industry for the analysis of pharma samples. The MCC is a non-profit corporation affiliated with the University of Puerto Rico. This organization provides state-of-the-art analytical services and the corresponding scientific and technical expertise for industry, academia, and government. The MCC facilities are located at the new UPR-Molecular Sciences Research Center (MSRC) and the UPR-Río Piedras campus Facundo Bueso building.

There exist several research initiatives through which our program collaborates with other UPR campuses. Some examples are with UPR- Mayagüez campus (NASA PR-SPRInT and NSF-CREST CIRE^{2}N research programs) while the NSF-CREST CIRE^{2}N program has collaboration with the UPR-Cayey campus Physics Department. Several of our graduate student have in their thesis committees, faculty from the UPR Medical Sciences Campus.

Through the Chemistry Graduate Association our graduate students participate in community outreach events, such as the annual American Chemical Society's (ACS) Chemists Celebrate Earth Week and the ACS National Chemistry Week. Several of our graduate students also participate in NanoDays, an annual event highlighting the uses of nanotechnology in research and our daily life, run by our NSF-CREST CIRE^{2}N and NSF-PREM CIE^{2}M programs. In addition, the MRSC holds a biannual Open House where school children, teachers, and the public can learn about the research and scientific work being performed at the center. Several of our faculty members have laboratories at the MRSC.

Two of our graduate students were awarded the Chateaubriand Fellowship from the France Embassy in Washington, DC and were able to do internships at chemistry laboratories in France for several months. A cotutelle MOU was signed between the University of Nantes, France, and UPR-Río Piedras campus to allow one of these students to received Ph.D. degrees from both institutions.

Several students have been in internships at the Brookhaven National Laboratories to conduct research in their synchrotron facility, as well as the Cornell High Energy Synchrotron Source (CHESS) in Ithaca, New York.

Several of our faculty members have been involved in the ACS Project SEED program. This joint UPR-Río Piedras and ACS sponsored program brings low-income high school students to campus for an 8-weeks research experience in our research laboratories. Mentorship is this program is provided not only by the research faculty, but also by our graduate and undergraduate students at the different host laboratories. The NSF REU: PR-CLIMB summer research program brings undergraduate students from the US and other Puerto Rico universities and provides research experience in Materials and Biomolecular Applications.

C. Dissemination and Services (Outreach) - The academic management of the Program communicates the current institutional regulations through e-mail messages and during the Graduate Seminar Series. We achieve sustained compliance through annual monitoring of student progress. We disseminate the mission, goals and objectives of the program and promote it through flyers, website/social networks, and mass communication media (online open forums through Google Meet). Students request information about how to apply to the program after obtaining information about it through those media and dissemination strategies. The Deanship of the College of Natural

Sciences has assigned personnel to update the webpage of all academic programs with their academic offerings and ensure compliance with institutional regulations and licensing and accreditation requirements, by the Board of Postsecondary Institutions (JIP for its acronym in Spanish) and the Middle States Commission on Higher Education. The program curriculum does not require the students to integrate themes, research, service, and cultural management of the communities, however, some individual research projects integrate community service.

D. Fiscal Aspects

Currently the Program has no operational budget assigned to it in the annual budget of the Department of Chemistry or the College of Natural Sciences. All Program expenses are covered by the Department of Chemistry budget. A line item in the Department of Chemistry budget for travel is reserved for use by the Program to cover the travel expenses of the speakers invited to participate in our Graduate Seminar Series. We would also like also for the line item in the Department of Chemistry budget for solvents, dry ice, gas tanks and liquid nitrogen be reserved for use by the Program. The previous Self-Study of the current M.S. and Ph.D. programs, which covered the academic years 2009-2010 to 2014-2015, described the lack of a separate budget for the Program as a weakness. Six years later, this is still the case.

In the past, alliances of individual researchers with industries such as Eli Lilly have allowed to bring some funds for lecturers, student scholarships, materials, and additional equipment.

A proposal to establish a fee-based summer camp program for high-school and middle-school students was presented to the Deanship of Graduate Studies and Research and is still under consideration. In addition, an alliance with the Division of Continuing Education and Professional Studies (DECEP for its acronym in Spanish) is being considered to offer workshops to teachers for a fee. Those resource would complement our current fiscal resources. The fiscal resources need to be improved to better achieve the goals and objectives of the program.

Self-Study Form

I. Program Foundations

A. Background

1. **Program Description**

a. Title of the program and degrees granted

Chemistry Graduate Program, M.S. and Ph.D. in Chemistry degrees.

b. Accreditations

The Bachelor's in Science in Chemistry Program of our campus is accredited by the American Chemical Society (ACS), however, the ACS does not accredit graduate programs in chemistry. Therefore, our Chemistry Graduate Program is not susceptible to receive accreditation from professional associations for its Master's and Ph.D. programs. Nonetheless, the Río Piedras Campus accreditation received from the Middle States Commission on Higher Education covers all graduate programs on campus. Alumni of the Chemistry Graduate Program can exercise their profession immediately after receiving their degree, but to practice as a chemist in industry or government in Puerto Rico they must obtain a license that is granted by the Board of Examiners of Chemists of Puerto Rico, in addition to becoming a member of the Puerto Rico Chemists Association ("Colegio de Químicos de Puerto Rico"). However, chemists with a Master's or a Ph.D. degree do not have to take the examination of the Board of Examiners of Chemists. To work in academia in Puerto Rico there is no need to be licensed by the Board of Examiners of Chemists.

c. Authorization and license

The M.S. and Ph.D. programs of the Chemistry Graduate Program were authorized and licensed by the Puerto Rico Higher Education Council ("Consejo de Educación Superior") in 1961 and 1970, respectively.

d. Administration

The Chemistry Graduate Program has a Coordinator and is assigned an administrative assistant from the Office of Graduate Studies at the Deanship of the College of Natural Sciences.

2. **Description of the Nature of the Program**

a. Research and creation

The Chemistry Graduate Program offers research-based graduate degrees. Faculty is recruited based on a recruitment plan that specifies the areas of the discipline where there is a need in the program. The applicant sends a recruitment package with a proposal of the areas of research that he/she will embark on once hired. Therefore, the research interests of the professors dictate the research and

creation done in the program.

b. Conceptual framework

The program conceptual framework is based on how to best educate professionals with knowledge in the fundamentals of Chemistry as a discipline with emphasis in scientific research training and expanding and disseminating knowledge. The fundamentals of the main areas of Chemistry (Analytical, Biochemistry, Inorganic, Organic, and Physical Chemistry) are emphasized, while also enabling experience in emerging interdisciplinary branches such as materials science, bioinorganic chemistry, supramolecular chemistry, and nanotechnology, among others.

c. Context and commitment with social needs

The program is committed to meet the needs, ideals and values of the Puerto Rican community responding to the need to train professionals with degrees in the chemistry field in the country to advance socio-economic development by developing high-level scientific research to make the research on the island competitive with the rest of the world.

The program continues to be successful in providing the much-needed college educators that teach the different areas of chemistry in all public and private higher education institutions on the island, as well as some in the Caribbean, Latin America, the United States, and other countries. The program promotes research and exchange of scientific knowledge locally and internationally.

3. **Program History**

a. Date established and context

The Chemistry Graduate Program was established in 1961 offering a master's degree with a doctoral degree added in 1970. Its origin is a response to the need to train professionals with degrees in the chemistry field in the country. In addition, the expansion of the chemical-pharmaceutical industry in Puerto Rico necessitated a labor force trained in the chemical sciences.

b. Accomplishments

Degrees granted. During its history the program has awarded 199 master's degrees and 299 doctoral degrees. During the period covered by this self-study, 4 master's degrees and 36 doctoral degrees were awarded.

Our students. Of all alumni respondents of the survey given as part of this Self-Study, 7 are currently working in academia (46.67% of respondents), 7 are working in industry (46.67%), and 1 (6.67% of respondents) is working in government.

Graduates of our program are successful professionals working in various academic activities, such as teaching and academic research, or in industrial manufacturing, both in Puerto Rico and abroad. Among them are professors at major universities abroad (e.g., Luis Echegoyen - University of Texas at El Paso (and former President of the ACS), Ángel Kaifer - University of Miami, Carlos

Crespo - Case Western University and Angel Martí - Rice University) and others who have occupied or occupy high administrative positions in government, industry or academia (e.g., José Lasalde, former Vice President of Research UPR System, Pio Rechani, former director of the Institute of Forensic Sciences, Roberto Aguayo, former President of the Puerto Rico Chemists Association, Raul Castro, former director of the Department of Chemistry and former Dean of Academic Affairs at UPR-Cayey, John Colberg, former Senior director at Pfizer), Marilyn García Arriaga, TS/MS Representative at Eli Lilly and Company, Hilda Sola, Senior Scientist at the Center for Testing and Advanced Technology Division, National Vehicle and Fuel Emissions Laboratory, US Environmental Protection Agency, Ivelisse Colón, Pharm Sci Team Leader at Pfizer, Dionne Hernández, Project Manager for Kilopower at NASA's Glenn Research Center, Azlin Biaggi-Labiosa, Manager, Electric Aircraft Propulsion Subproject, Transformational Tools and Technologies Project at NASA Glenn Research Center, and Ingrid Montes, Director-at-Large of the American Chemical Society Board of Directors.

Several of our students have been successful in obtaining prestigious national and international fellowships such as the US National Science Foundation's Graduate Research Fellowship, NASA ASTAR Fellowship, and the Chateaubriand Fellowship of the government of France.

Relationships. The program maintains relationships with service centers and organizations such as the Materials Characterization Center (MCC), the University Industry Research Center, Inc. (INDUNIV), the Food and Drug Administration (FDA), the American Chemical Society (ACS), the International Union of Pure and Applied Chemistry (IUPAC), the National Science Foundation (NSF), the National Institutes of Health (NIH), the Department of Energy (DOE) and the National Aeronautics and Space Administration (NASA).

Publication and creation. In the past 5 years (Academic Years 2014-2015 to 2019-2020) professors have published a total of 294 papers for an average of 59 publications per year and the average number of publications per year among professors that published was 3. Professors in the program have registered four (4) patents and another two are pending, another three have provisional status, while an international invention disclosure has been accepted. The students and professors in the program have a very high number of presentations at local, national and international scientific conferences.

Collaborations. The professors in the program maintain a high number of interdepartmental-, intercollege-, intercampus, and interuniversity projects, with universities in the country and abroad, as well as with industries, government agencies, and research institutes (see Section III.C).

In addition, program faculty are appointed to journal editorial boards of high international prestige and as critical reviewers of manuscripts in high impact peer-reviewed journals and of colleagues' proposals to federal and international agencies (see Section III.C). There are professors who have been elected as "Fellow" of the American Chemical Society (ACS), the International Union of Pure and Applied Chemistry (IUPAC), the Royal Society of Chemistry (United Kingdom) and the American Association for the Advancement of Science (AAAS), and who have been members of the Board of Directors of the ACS, the Board of Directors

of the AAAS, and Divisions of IUPAC.

Proposals approved and external funds obtained. For the reported 5-year period the following number of proposals have been approved: ten (10) in 2015-2016, six (6) in 2016-2017, four (4) in 2017-2018, one (1) in 2018-2019, and six (6) in 2019-2020 for a total of $34,872,107.

c. **Significant changes since its creation and the reasons behind those changes**

The first significant change that the program underwent was to begin offering courses toward a doctoral degree from 1968 (the Ph.D. program was approved in 1970), a result of the need to develop scientific research for high-level research in the island competitive with the rest of the world. The second significant change was the elimination of the requirement of cumulative exams in 1995 on the understanding that it took too much time of the students which prevented them to focus earlier in scientific research. The third significant change in the Program was the implementation of Proposal A in 1997 to allow students to articulate early in their doctoral studies their thesis proposal and to begin the thesis research quickly. Another significant change was the formalization of rotations during the first semester of the students' entry to the Program that started in the year 2009 to make students choose their research mentor as quickly as possible after learning about the research carried out by at least three (3) professors in the Program.

d. **How the program's update process attended the needs and requirements in the evolution of the discipline or profession and institutional ones to which the program responds?**

The program update process reflects the current educational and research trends in the field of Chemistry to better serve the current needs of our graduate students. The Chemistry Graduate Program decided to revise both the M.S. and Ph.D. programs to implement some of the current trends at the graduate level we have observed in other successful Chemistry Programs. We examined the requirements of the Top Ten Chemistry Graduate Programs in the USA (California Institute of Technology, Massachusetts Institute of Technology, University of California-Berkeley, Harvard University, Stanford University, University of Illinois, Northwestern University, Scripps. University of Wisconsin-Madison, and Cornell University, as well as those of selected Chemistry Graduate Programs in the USA that are comparable to our Chemistry Graduate Program in terms of publications, number of grants and facilities (Florida State University and New Mexico State University). A recent report by a Presidential Commission of the American Chemical Society (ACS) on graduate education[3] concludes that "current educational opportunities for graduate students, viewed on balance as a system, do not provide sufficient preparation for their careers after graduate school". The Commission also concluded that "the state of graduate education in the chemical sciences is productive and healthy in many aspects but has not kept pace with the significant changes in the world's economic, social, and political environment since the end of World War II, when the current system of graduate education was

[3] *Advancing Graduate Education in the Chemical Sciences: Summary Report of an ACS Presidential Commission.* American Chemical Society: Washington, DC, 2013, p. 4.

formed." The Commission also states that "the primary purpose of graduate education is education", with a first focus being "to educate students to solve problems in society, including the effective education of the succeeding generations". At the Master's level, the Commission states that the focus is to "develop scientists and engineers with augmented technical knowledge beyond the undergraduate level, sometimes toward specialized professional capabilities". As a graduate program, we believe that scientific writing is one of such professional capabilities.

In addition, in the 2020-2021 Academic Year, a survey of the students in the Chemistry Graduate Program that we conducted as part of the Self-Evaluation of the program indicated the generalized satisfaction with the Program. Some students expressed their concerns that the Program was not up-to-date, and some wrote that it did not prepare them with the skills needed in today's world and employment opportunities, resonating with the conclusions made by the Presidential Commission of the ACS. A total of thirty-six (36) students (46%) out of seventy-eight (78) currently enrolled in the Graduate Program completed the survey and provided input that gives useful information on the proposed Chemistry Graduate Program revisions.

Related to the general perception of the program, 69.44% of graduate students, 53.33% of alumni, and 100% of faculty consider that the mission, goals, and objectives of the program are excellent or good. In addition, 58.33% of graduate students, 60% of alumni, and 100% of faculty consider that the curriculum of the program is excellent or good. Furthermore, 77.78% of graduate students, 66.67% of alumni, and 100% of faculty consider that the research in the program is excellent or good. Also, 80.56% of graduate students, 73.33% of alumni, and 100% of faculty consider that the faculty of the program is excellent or good. About bibliographic resources, 66.67% of graduate students, 33.33% of alumni, and 42.85% of faculty consider them excellent or good. In addition, only 22.22% of graduate students, 26.67% of alumni, and 14.28% of faculty consider that the physical facilities of the program are excellent or good. Furthermore, only 44.44% of graduate students, 40.00% of alumni, and 28.57% of faculty consider that the technology of the program is excellent or good. Finally, only 36.11% of graduate students, 53.33% of alumni, and 42.86% of faculty consider that the academic management of the program is excellent or good.

Regarding the number of requirements to complete the degree, a larger percent of respondents believe that they are too high than in the survey conducted five years ago. The Chemistry Graduate Program responded to these results by revising and lowering the number of requirements in the proposal for revision of the M.S. and Ph.D. programs.

The Chemistry Graduate Program has developed the proposal to revise the current M.S. and Ph.D. programs and to establish a new M.A. program with no thesis based on both the need to comply with current campus Policy on Graduate Studies and Research (Certification #95, 2019-2020, of the Academic Senate) and the need to update our program to reflect the current educational and research trends observed in other successful Chemistry Programs. This proposal has already been approved by the Department of Chemistry and is currently under evaluation by the Deanship of the College of Natural Sciences and of Graduate Studies and Research. We expect that these changes will improve the overall

quality of the Program in terms of graduation rate and productivity, as well as serve to better develop capabilities in our graduates to provide them sufficient preparation for their professional careers after graduate school.

In the five years covered by this self-study the program enrollment ranged from a maximum of 91 (2019-2020 academic year) and a minimum of 79 students (academic year 2016-2017) (see Table 4.1.A). Out of 64 new students enrolled in the program during the five years of this self-study, 15 (23%) were international students. The recent decline in enrollment (Table 4.1.A) reflects the decrease in the number of jobs due to the closure of pharmaceutical plants on the island in recent years.

B. Vision, Mission, Goals and Objectives of the Program

Fill in the table with the philosophical (**Vision**[4] and **Mission**[5]) and programmatic (**Goals**[6] and **Objetives**[7]) foundations that the Program has and its alignment with the Goals and Objectives of the Strategic Plan of the Río Piedras Campus. The spaces provided in the table suggest the sequence of information required. From the vision, the mission emerges, and from the latter, the goals and objectives. Adjust the table to suit the number of goals and objectives your Program has. Do not try to fix or develop the fundamentals during the evaluation process; if these require some adjustment, the revision exercise must be part of the Development Plan.

Table 1.1.C: Vision, Mission, Goals, and Objectives of the Program and its Alignment with the Strategic Plan of the Río Piedras Campus

Vision: We aim to develop lifelong learning, creation, and dissemination of knowledge at national and international level and the training of professionals of chemistry that promote scientific, social, and economic development, to improve the quality of life in Puerto Rico, the Caribbean, and the world.
Mission: The mission of the Ph.D. program of the Chemistry Graduate Program is to educate and train professionals with knowledge in the fundamentals of chemistry, while providing an enabling experience in a specific area belonging to one of the classic branches (Analytical Chemistry, Biochemistry, Inorganic Chemistry, Organic Chemistry, Physical Chemistry) or emerging interdisciplinary branches such as materials science, bioinorganic chemistry, supramolecular chemistry and nanotechnology, among others. The preparation of professionals in chemistry at an

[4] The vision is a clear picture or written statement of what the program is expected to look like at a future point in time. This image endows the program with a sense of direction; pinpoint where you are heading in terms of strategic planning.

[5] The mission is a statement that presents the function of the program, its reason for being, its academic focus (research and / or professional), its areas of specialization and that particularity that makes the program unique. This affirmation lays the foundations of the curricular design, establishing the lines of investigation and the areas of service. It defines the relationship of the training of students with the production of knowledge and service to the community. In addition, it suggests the structure and guides the operation of the program. It is written in a precise, concise and affordable way.

[6] The goals of the program are statements that set out in broad terms the responsibilities of the program to achieve the performance of its mission, its main function: to train students. The goals establish the purposes from which the programmatic and managerial components of the program are derived. They implicitly or explicitly contain an indicator of achievement. Each goal is operationalized through a number of objectives.

[7] Program objectives are operational statements that detail the responsibilities mentioned in the program goals. They provide criteria and measurable information (qualitative and / or quantitative) through which you can plan, determine progress and facilitate future evaluation of the program. Achievement indicators are derived from program objectives, usually quantitative parameters against which the performance of the different components of the program is measured.

advanced level also seeks to develop in them the importance of creating a safe environment in the work area, the ability to identify major problems in the discipline and to design effective strategies for solving them by encouraging good laboratory practices, interdisciplinarity and collaboration at the departmental, national, and international level. In a broader context, the mission of the Graduate Program is to prepare professionals to practice their profession with the firm intention of advancing knowledge in chemistry, bringing this knowledge to solve problems of daily life and human welfare while instilling in our students hard and soft skills sets that will directly prepare them for post-graduate work and to promote scientific, social, and economic development to improve the quality of life in Puerto Rico, the Caribbean, and the world.

Río Piedras Campus Strategic Plan		**Chemistry Graduate Program**	
Goals	**Objectives**	**Goals**	**Objectives**
• The Campus will increase the production of innovative knowledge to through research and creative activity.	• 1.1.1 Increase the allocation of resources to support the research and creation. • 1.1.2 In collaboration with academic programs, develop and implement a recruitment plan and retention of professors of excellence, according to changes in disciplines, emerging areas of research and creation and requirements of accrediting agencies. • 1.1.3 Strengthen available research institutes as assets of the Campus through interdisciplinary and transdisciplinary collaboration between programs, other units of the UPR System, as well as with	● Promote research and exchange of scientific knowledge with local and international peers to contribute to the enrichment of knowledge in that discipline. ● Maintain the physical infrastructure and the advanced instrumentation that can provide the necessary support to carry out education and research competitive within a safety culture	● To encourage scientific, creative, and critical research, framed in the ethical-professional commitment. ● To identify institutional and external funds to provide a physical and administrative infrastructure that allows sustaining and optimizing the operation of the program to efficiently serve a heterogeneous audience of students and professionals

Río Piedras Campus Strategic Plan		Chemistry Graduate Program	
Goals	**Objectives**	**Goals**	**Objectives**
	universities and centers internationally.		
• 1.2 The Campus will increase external funding through research and creation.	• 1.2.2 Increase the commercialization of patents and innovational projects. • 1.3.1 Increase dissemination of research and creative production at the local and international level. • 1.3.2 Sponsor local and international congresses for the dissemination of research and creation.		
• 3.1 The Río Piedras Campus will strengthen the relationship with its social and physical environment through teaching, research, assistance in public policy formulation, cultural management, and service to communities.	• 3.1.2 Increase initiatives for collaboration, improvement of conditions and support to communities, through: colleges/ schools, academic programs, practice courses and internships, volunteer work and tasks assigned or led by students; the Urban Action, Community and Business Center (“Centro de Acción Urbana, Comunitaria y Empresarial,	• Address the needs of the Puerto Rican community by developing projects and providing chemistry advice	● To contribute to the solution of issues and problems related to Chemistry and the sciences, arts and industries related to it. ● To link the University with the world reality to improve the well-being of the human being. ● To advance the knowledge of Chemistry and ensure human well-being by providing ideas for solving problems in society

Río Piedras Campus Strategic Plan		Chemistry Graduate Program	
Goals	**Objectives**	**Goals**	**Objectives**
	CAUCE) and other units or Campus projects.		beyond the research laboratory. ● To offer chemical advice to the community, the country's educational system, the government, and industries

Answer the following questions referring to the information provided in Table 1.1.C.

1. **Vision**

   a. **Does the program have a Vision?**

      - ☒ Yes (Go to the next question.)
      - □ No (Skip to the questions about the Mission.)

   b. **Relationship between vision and strategic planning** Does the Vision define where the program is heading in terms of strategic planning? Does it respond to the strategic plan of the Río Piedras Campus?

      As part of the process to write a proposal for the revision of the M.S. and Ph.D. in Chemistry programs and establishment of a new M.A. in Chemistry program (with no thesis requirement), the faculty of the program updated its Vision and Mission. The Program's Vision responds to the Strategic Plan 2018-2023 of the Río Piedras Campus (Certificate No. 79, 2017-2018, of the Academic Senate) and emphasizes to: (a) achieve and maintain excellence in education, research, and dissemination of knowledge, (b) a commitment to comprehensive student training and lifelong learning, (c) the dissemination of knowledge nationally and internationally, and (d) contribute to the scientific, social, and economic development to improve the quality of life in Puerto Rico, the Caribbean, and the world.

2. **Mission**

   a. To what extent does the **Mission** mention the function of the program, its reason for being, its academic approach (research and / or professional), its areas of specialization and / or that particularity that makes the program unique? (See footnote 6)

      The Mission of the program mentions the function of the program, its reason for being, its academic research approach, its areas of specialization. The Chemistry Graduate Program is the only Ph.D. in Chemistry granting program on the island.

   b. **Alignment between the mission, goals, and objectives of the program with those of the Río Piedras Campus.** Refer to Table 1.1.C to evidence the

alignment between them.

This Mission of the Chemistry Graduate Program is consonant with that of the Rio Piedras Campus with respect to providing graduate education of the highest quality that develops the capacity for independent study and research and to help strengthen undergraduate education. In addition, training of professionals of the highest caliber, committed to the ideals and values of Puerto Rican society. Similarly, developing teaching, research, and development and internationally dissemination of knowledge.

c. ¿Is the Mission of the Program still valid[8] ? ☒ Yes □ No

As part of the process to write a proposal for the revision of the M.S. and Ph.D. in Chemistry programs and establishment of a new M.A. in Chemistry program (with no thesis requirement), the faculty of the program recently updated its Vision and Mission. The new Vision and Mission were approved at the Department Level in January 2021. The program's Mission continues to be to educate and train professionals with knowledge in the fundamentals of Chemistry as a discipline. Its purpose is to prepare professionals to practice their profession with the firm intention of advancing knowledge in chemistry, bringing this knowledge to solve problems of daily living and human welfare and its academic approach is to promote good practices in the laboratory, interdisciplinarity, and collaboration at the departmental, national, and international level. In addition, the program's Mission emphasizes its contribution to the scientific, social, and economic development of the country to improve the quality of life in Puerto Rico, the Caribbean and the world. The feature that makes the program unique is that it has areas of expertise that provide an enabling experience in a specific area belonging to one of the classic branches or emerging interdisciplinary branches such as materials science, bioinorganic chemistry, supramolecular chemistry, and nanotechnology, among others.

3. **Goals and Objectives of the Program**

a. In what way the **Goals of the Program** expose in general terms their relationship with the main responsibilities of the Program, the training/learning of students, the recruitment and development of faculty, research and production of new knowledge, infrastructure, management, service, and relations with the community?

The Program Goals present the main responsibilities of the program which are to prepare students as competent professionals, promote research and exchange of scientific knowledge locally and internationally, meet the needs of the Puerto Rican community, and maintain a physical infrastructure with advanced instrumentation.

b. To what extent does the **Program Objectives** enunciate operationally the concrete actions and specific activities to be carried out to fulfil the responsibilities mentioned in the **Goals of the Program**?

[8] The validity of the mission is related to the development of the discipline or profession, the current requirements to exercise it, the rate of obsolescence of the field, the employment market and the social context within which the Program is framed.

The Program Objectives offer a global view on the activities without specifying concrete actions with metrics; they are general rather than specific. No specific activities are established although the activities to be carried out to meet the program goals can be inferred.

c. Does each objective define the **indicator and metric of expected achievement,** that is, the measurable information (qualitative and/or quantitative) through which future assessment of the operational aspects of the program can be facilitated?

The Objectives of the program do not define the indicator and metric of expected achievement. However, we evaluate the fulfilment of the objectives of the program through the assessment of student learning, the number of publications, presentations, funding of professors through grants or competitive programs, the number of approved proposals, collaborations with industry and government, and the number of undergraduate and high school students participating in research.

d. What modifications, if any, were made to the program goals and objectives to update it? Indicate the effective date of the change.

As part of the process to write a proposal for the revision of the M.S. and Ph.D. in Chemistry programs and establishment of a new M.A. in Chemistry program (with no thesis requirement), the faculty of the program recently updated its Vision, Mission, Goals and Objectives. The effective date was on January 22, 2021, when the revision of the M.S. and Ph.D. in Chemistry programs was approved by the Department of Chemistry.

C. Need and Justification of the Program

Describe the scope of the program in response to the needs of the population.

1. What data supports that the program was adequate to meet the identified needs and opportunities?

The student, alumni and faculty survey results are evidence that the program was adequate to meet the identified needs and opportunities.

2. Which are the needs and expectations justifying the continuation of the program?

In this third decade of the 21st century, there is still a demand and a need to train and create the human and intellectual resources needed to make Puerto Rico an attractive place for increasing new fundamental knowledge, development of new technologies and enterprises with capable personnel, who have the capacity of adapting to the changing paradigm of science and technology entrepreneurship while promoting scientific, social, and economic development in Puerto Rico, the Caribbean, and the world.

D. Relevance of the Program

This section recognizes the unique characteristics of the program, the existence of other similar programs, the relationship with other programs, demand, and other relevant aspects.

1. What characteristics distinguish and make the program a valuable and unique study alternative, in the Río Piedras campus, in the UPR System, and in comparison, with other institutions?

   The characteristics that distinguish the program in comparison with others in Puerto Rico is that it is the only program on the island that offers a Ph.D. in Chemistry degree. In addition, the quality of the faculty on the program, their research fields of study are current, state-of-the-art, the number of publications, grants, and the opportunities for graduate students to participate in internships and collaborative research programs at world-renowned institutions (academic, government and industry), are unique on the island. There is a Ph.D. in Applied Chemistry program at the UPR-Mayagüez campus, but it has a different scope.

2. What is the impact of the program on other programs or departments of the faculty, the Río Piedras Campus or the UPR System? Include matters such as shared courses or research focus areas, interdisciplinary activities, among others.

   The Chemistry Graduate program has impacted other departments on the College of Natural Sciences. For example, in 1981 we established a collaborative program developed with the Department of Physics, leading to a Ph.D. program in Chemical Physics; the program is administered by the Department of Physics. In addition, demand for courses by students of the Department of Physics is high since they all take the Physical Chemistry core course given by professors in our program. Also, students in our program have Co-mentors from the Biochemistry and Pharmacy departments of the UPR-Medical Sciences Campus and sometimes these professors are involved in collaborative research with professors in our program. Our graduate students are teaching assistants in the undergraduate General Chemistry, Organic Chemistry, Analytical Chemistry, and Physical Chemistry courses; the General Chemistry and Organic Chemistry courses are taken by students in the undergraduate Chemistry Program but also by students in other departments.

3. If programs of another level in the discipline or professional area are offered, what is their relationship with the program under evaluation?

   The Chemistry Graduate Program includes both a M.S. in Chemistry program and a Ph.D. in Chemistry program. The course offering and professors are the same for both programs.

4. Which data and information demonstrate the interest of industry, research centers and other educational institutions or agencies? Include data from the last five years and projections.

   There is a research area related to crystallization and drug polymorphism that is conducted at the Crystallization Design Institute lead by Dr. Vilmalí López in collaboration with the pharmaceutical industry and Dr. Torsten Stelzer of the Pharmacy School of the Medical Sciences Program. In addition, the X-day diffraction facilities created by two faculty members of the Chemistry Graduate Program, Dr. Dalice Piñero and Dr. Vilmalí López, have been invited three times to offer continuing education course to industry professionals of the Puerto Rico Chemist Association (“Colegio de Químicos de Puerto Rico”). Some of our research centers are in collaboration with other institutions, such as Cornell University and the Ana G.

Méndez University in our NSF-PREM Center for Interfacial Electrochemistry for Energy Materials (CIE^{2}M). In addition, our NSF-CREST Center for Innovation, Research and Education in Environmental Nanotechnology (CIRE^{2}N), is in collaboration with the UPR-Cayey and Mayagüez campuses, the Ana G. Méndez University, Brookhaven National Laboratory, Los Alamos National Laboratory and the NSF Center for Sustainable Nanotechnology, a multi-institutional partnership aimed at developing a molecular-level understanding of the fundamental chemical and physical processes that govern the transformations and interactions of nanoparticles in the environment. The Puerto Rico Space Partnership for Research Innovation and Training (PR-SPRint) is a collaboration with NASA Ames and Glenn Research Centers. We are currently trying to be included in the NASA Kennedy Space Center's Growing Beyond Earth program, which is studying which plants and microalgae to grow in space. Recently, two professors in the program started collaborating with the EPA Addressing Environmental Concerns in Vieques, Puerto Rico Through Community Participatory Research Program with the Community-driven assessment of environmental health risks in Vieques, Puerto Rico grant, led by the University of Massachusetts Boston and the Boston University School of Public Health.

5. Which trends have been observed in the past five (5) years in terms of enrollment, applicants, and occupancy percentages of the program.

In the 2020-2021 academic year we have 78 students (January 2021) enrolled in the program. Below we include a graph of the enrollment trend since the 2004-2005 school year. In the last five years the number of enrolled students has more or less stabilized (see Figure 1).

Since 2017-2018, there has been a reduction in the number of applications received in comparison to the base-year 2015-2016; a similar trend was observed in the number of students admitted. However, the incoming students rate ranged from 8 to 14 students. The total number of graduate students enrolled increased, albeit slightly, for the 2019-2020 academic year. Lastly, the number of degrees conferred remained relatively stable between 7 and 9 per academic year.

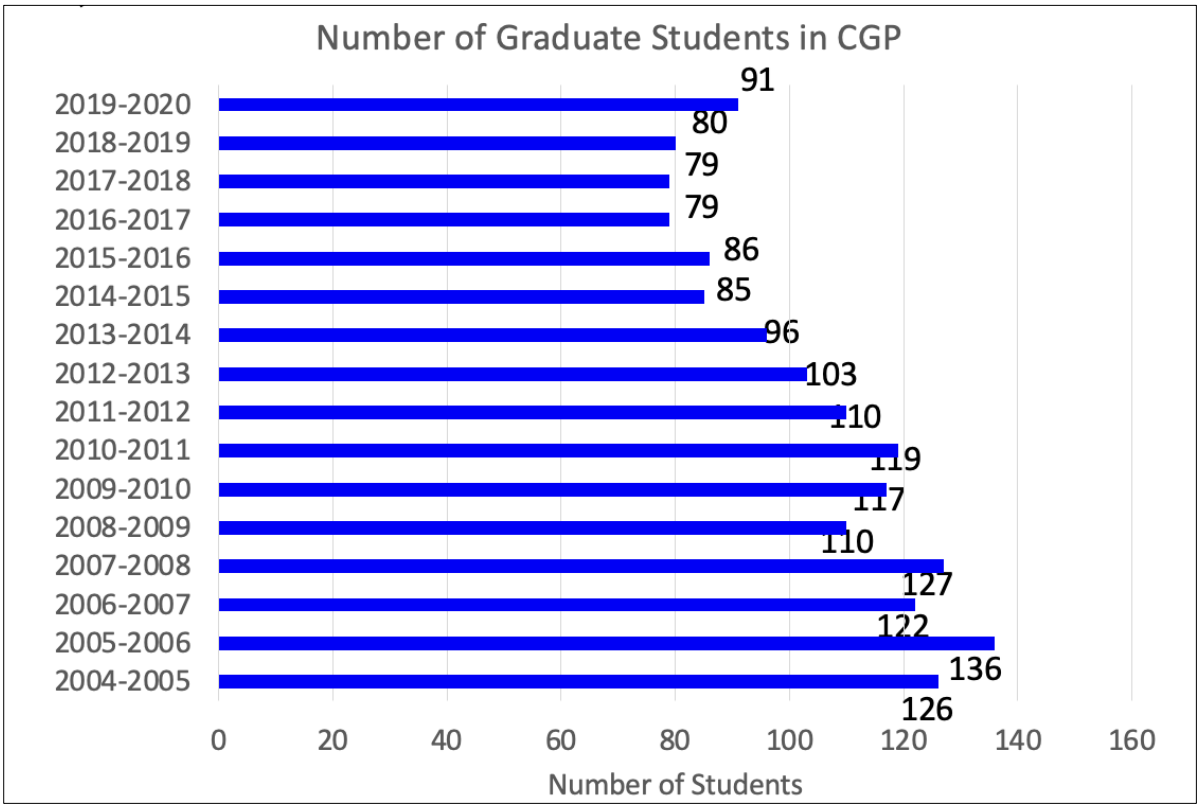

Figure 1. Number of Graduate Students in Chemistry Graduate Program since 2004-2020

E. – Student Profiles and Learning Objectives

Fill in the table with the information you have and align the **Profile of the Incoming Student**, the **Learning Objectives,** and the **Alumni Profile**. Provide the year of approval for each in the headers of each column. If you have different objectives for each specialty, you should include them. The purpose of this table is to demonstrate the correspondence between the performance expectations set for students before, during, and after graduation and to raise awareness of the need for these fundamentals.

Table 1.2.D – Alignment of Student Profiles and Learning Objectives

Accrediting Agency Standard (if apply)	**New Incoming Student Profile** (2016)	**Learning Objectives** (2019)	**Alumni Profile** (2021)
	To have successfully completed a B.S in Chemistry from an accredited institution and therefore have a basic understanding of the different areas of chemistry.	To demonstrate and master the fundamental concepts of Chemistry and become a specialist in fundamentals and technical skills in an area of knowledge within Chemistry, such as: Analytical, Biochemistry, Physics, Inorganic or Organic.	To master the fundamental concepts of Chemistry as a discipline, its applications in daily life and its relationships with other scientific disciplines.
		To apply the concepts of Chemistry to the solution of theoretical and practical problems that require an interdisciplinary approach.	To master the technical skills required to practice the profession as a Chemist.
	To have demonstrated ethical behavior during their undergraduate years in solving their individual assignments.	To have the ability to recognize important problems in their area of scientific expertise and to design effective strategies and / or experiments to solve them. To exhibit ethical behaviors in their academic performance.	To Carry out scientific, creative, critical and innovative research, to offer solutions and generate knowledge framed in the ethical - professional commitment.

	To demonstrate effective competence in oral and written communication, in Spanish and/or English, and the use of Information Technology.	To handle scientific literature correctly as a support for solving chemical problems.	To know the scientific literature and have the ability to use the information obtained in solving problems.
		To have independence of criteria in decision-making, creativity, and initiative in the search for solutions to scientific problems that arise.	To exercise independence of criteria and show creativity and initiative to contribute to the solution of issues and problems related to Chemistry and the sciences, arts, and other related enterprises.
	To demonstrate knowledge about safety measures in laboratories and the proper handling and disposal of chemical substances.	To demonstrate knowledge about safety measures in laboratories and the proper handling and disposal of chemical substances. To identify and apply the occupational safety and environmental protection standards of the discipline.	To integrate theories, practical protocols that protect the environment, and ethical and safety protocols to their professional or investigative work.
	To have the minimum knowledge to be able to work in a research laboratory in chemistry having proficiency in laboratory techniques and the use of classic and modern laboratory equipment.	To demonstrate knowledge of scientific instrumentation as a support tool in solving chemical problems.	To know the instrumentation and technological resources as support tools in the design of experiments and problem solving.
	To demonstrate effective competence in oral and written communication, in Spanish or English, and the use of Information Technology.	To demonstrate technical ability to make presentations (in terms of clarity and organization of ideas, ability to argue, quality of visual media, personal projection, and time management) to a diverse scientific community in Spanish and English.	To possess the ability to communicate the fundamental concepts of their discipline through different forms of teaching to diverse groups

	To have the ability to develop independent study (self-taught), interest and motivation to continue learning fundamental concepts of chemistry and in their area of specialization.	To demonstrate the ability to keep their knowledge up to date in a self-taught way through continuous learning.	To have the capacity for individual learning and professional improvement.
		To identify and apply the occupational safety and environmental protection standards of the discipline.	To show commitment to the protection of natural, environmental, and cultural resources through the best practices of chemistry and occupational safety and environmental protection standards.
			To show respect for human rights through actions of social inclusion and commitment to diversity
	To have the ability to work in a group.	To demonstrate command of relationships and interpersonal skills for teamwork with people from diverse cultural backgrounds.	To demonstrate collaborative research ability by working in multi-, inter- and trans disciplinary teams.
			To assume and promote leaderships that contributes to individual and collective transformations.
	To have the minimum knowledge to be able to work in a research laboratory in chemistry having knowledge of laboratory techniques and the use of classic and modern laboratory equipment.	To demonstrate knowledge of scientific instrumentation as a support tool in solving chemical problems	To show mastery of knowledge, competence in instrumentation and technical skills within their specialty in Chemistry.
		To have the ability to recognize important problems in your area of scientific specialty and to design effective strategies and / or experiments to solve them.	To identify important problems inherent to Chemistry and other disciplines to design effective strategies and / or experiments to solve them.

Answer the following questions taking as reference the information provided in Table 1.2.D.

1. **New Student Profile**

   a. Does the Program has a **New Incoming Student Profile** that details the baseline competencies that the student should have as a startup point in the Program? Or does it only have a list of admission pre-requisites? If the latter, then when does the Program hopes to have a final profile?

      The program has a profile that incoming graduate students must have and there is a list of admission requirements.

2. **Alumni Student Profile**

   a. Is there correspondence between the **Alumni Profile** and the needs and opportunities of the labor or academic market.

      Yes. According to the latest survey of alumni of the Chemistry Graduate Program (see attachment), 93% of survey respondents belong to the labor force with full time positions, and 87% are working in an area related to their discipline of studies. These statistics reflect that the labor market opportunities properly correspond to our graduate profile and the academic training received by the students in our program.

   b. Does the profile of the graduate program alumni includes the research / creation competencies that will be integrated throughout the curriculum sequence of the program?

      Yes. The alumni profile emphasizes scientific, creative, critical, and innovative research, to offer solutions and generate knowledge framed in the ethical - professional commitment.

   c. In what way does the **Alumni Profile** gathers the skills and tasks that the alumnus must show during the initial stages of his/her career?

      The graduate profile includes the mastering of the fundamental concepts of the discipline, mastering of laboratory techniques required in the profession, students must possess the ability to communicate the basic concepts of chemistry, and present in oral and written form the results of their research, among others. These acquired abilities of the graduates are evaluated by supervisors from the time he/she first participates in a job interview and through the evaluation process during the first months of their careers.

   d. Is the level of requirements for the **Alumni Profile** in tune with the expected degree (e.g., Master's or Ph.D.)?

      Yes. According to the survey administered to graduates of the program, 47% of the alumni expressed that the standards of the program are Excellent or Good, 33% expressed the requirements are Regular and 20% expressed that the requirements were Deficient or Very Deficient. The proposals for the new M.S. and Ph.D. will correct this later point.

3. **Learning Objectives**

a. To what extent is the relationship between the student's **Entry** and **Exit Profiles** and the **Learning Objectives** evident? Are there any misalignments between one and the other that could be influencing on course content and, consequently, on student learning?

The incoming student profile is well aligned with the alumni profile. The course work, research training and the other academic exercises, such as seminars, proposals and workshops provide the student a well-rounded education. The Learning Objectives were designed considering the student's Entry and Exit Profiles and approved by the campus' Office of Student Learning Assessment.

b. To what extent do Learning Objectives indicate the competencies that students must demonstrate during their tenure within the program?

The learning objectives were designed so that students can demonstrate their progress throughout their studies by different evaluation exercises, such as Proposal A, the Graduate Seminar, Proposal B, and thesis defense. Being able to demonstrate mastery of the fundamental concepts of chemistry, application and integration of these concepts, wording in documents of research nature, among others (see Table 2.1.A), are the core of each of these exercises, which they can be evaluated by the thesis committee.

c. Are these measurable? Are they operationally defined, in behavioral terms?

Yes, they are measurable and defined in behavioral terms. Several are described directly and others indirectly. However, all the included verbs are measurable.

d. Is their format appropriate? Do they begin with an action verb in the infinitive? Are they written according to what the student (not the professor) should be capable of doing? Are they ordered from the simplest competencies to the most complex ones?

Yes, they are written in infinitive, with action verbs. Everything is focused on what the student will be able to do and can be sorted according to their level of complexity.

e. Are competencies ordered from the simpler to the more complex ones?

Although they are not necessarily ordered from simple to more complex, they tend to follow the order established in the campus Graduate Alumni Profile - Certificate 104, 2016-2017, of the Academic Senate.

f. Are learning objectives aligned, do they harmonize with the Alumnus Profile? Can the program infer then, that through those objectives the students should be prepared to the exercise of their careers?

Yes. Table 1.2.D. - Alignment of Student Learning Objectives and Profiles shows a direct alignment between the two columns, so we can infer that the learning objectives of the program were met. Participants must leave prepared to perform satisfactorily in their careers. According to the survey administered to alumni of

the program, only 26% expressed dissatisfaction with the preparation it offered.

g. Have there been significant changes, or do you foresee significant changes to the study areas of the program, are those changes reflected in the New Incoming Student Profile, Learning Objectives, and the Alumnus Profile?

In past years significant changes have occurred in the study areas of the program (by adding Special Topic courses in nanotechnology, supramolecular chemistry, bioinorganic chemistry, and biophysics, among others) and major innovations have been proposed within the preparation of the Development Plan for the next five years. However, these innovations do not intend to radically change the profile of the incoming student, the learning objectives, and the alumni profile. We will continue to pursue a program of excellence in education and research.

F. Assessment[9] of Results: of the Program and Student Learning

1. Assessment of the Program Results

In this section the assessment plan and mechanisms that the program uses to determine success in the accomplishment of the Program's mission, goals and objectives (institutional effectiveness) are examined.

a. Which structures, processes and strategies or instruments have been used to evaluate the effectiveness of the program (accomplishments of the goals of the program), how these are related to the program assessment plan (current development plan), and with the student learning domains for the graduate programs of the Río Piedras campus?

The Program prepared a Self-Study Survey for the 5-year Self-Study Report. Based on the results of the previous Self-Study, the program engaged in a complete revision of the M.S. and Ph.D. programs and decided to propose the establishment of a new M.A. program in Chemistry with no thesis requirement. In addition, based on the results of the previous Self-Study, the program prepared a 5-year Development Plan. The program prepared a draft of a report of the implementation of the 5-year Development Plan, which detailed how the 2017 student strike and the Hurricanes Irma and María had negatively impacted the implementation of the 5-year Development Plan. More recently, the earthquakes' swarm that occurred starting in January 2020 and the still ongoing pandemic had further delayed the implementation of the Development Plan. As part of the current Self-Study, we will update the current 5-year Development Plan, which will consider the results of the new Self-Study Survey.

b. What do the results of the evaluation of the effectiveness of the program show?

According to the Self Study Survey, 69% of the people think that the effectiveness of the program to accomplish its goals is high.

c. To what extent did the program fulfill its expected scope and purposes?

In terms of the alumni profile, the results of the Self-Study Survey indicate that the

[9] Assessment: Process by which, systematically and using a variety of methods or strategies, data on the performance of students, the program and the institution is collected and analyzed in order to improve and strengthen it.

students that graduate from the program are well-prepared to continue careers in the Chemistry field and fulfill the alumni profile. Of the participants of the survey, 42 out of 58 (72%) strongly agree or agree that the programs curriculum provides the skills and knowledge necessary to perform successfully in the world of work.

In terms of student recruitment, we have experienced a decrease in applications to the program. This decrease is related in part to the economic conditions on the Island since it has been in an economic crisis for the last decade and a half. The number of large and numerous pharmaceutical industry plants that used to be on the island have decreased as some of them had been moved abroad. In addition, the offer that we make to students is not competitive to the offers that they receive from programs in the US. The salaries for TAs in our program have not been raised for at least two decades.

Many of our best B.S. students pursue graduate studies in the US.

In terms of student retention, the large number of requirements in the program has resulted in students taking a longer time than expected to complete their degree than expected. Some students have abandoned plans to continue in the program or pursue a Ph.D. degree after completing a M.S. degree due to that aspect of the program. We are aiming to improve this situation with the revision of the M.S. and Ph.D. program which has already been approved at the Department level and is currently being reviewed at the College of Natural Science level.

In addition, the problems with the infrastructure, equipment maintenance, purchasing delays, etc. do not encourage students to remain in the program upon completion of M.S. degrees.

Nevertheless, the number of students that are being able to complete their Ph.D. degrees in a period of 6 years or less has either remain constant or increased, as evidenced by the table in page 92.

d. What curricular, instructional, or other changes were made considering the data on program performance?

The revision of the M.S. and Ph.D. program that is currently being reviewed at the College of Natural Science level includes the following curriculum changes:

1. The M.S. program credit requirement was reduced from 42 to 30 credits, whereas the Ph.D. program credit requirement was reduced from 75 to 59 credits for students that start the program with a B.S. degree. In addition, for students who enter the program with a M.S. degree, the Ph.D. program credit requirement is now 47 credits.
2. The qualifying exams have been eliminated for both the M.S. and Ph.D. programs. For the Ph.D. program they have been replaced with a Candidacy Exam.
3. A Scientific Writing course has been included as a requirement in both the M.S. and Ph.D. programs, to better prepare the students to write their Thesis Research Plans, Graduate Seminars, original proposals, research manuscripts and theses.
4. Proposal B was replaced with an original proposal requirement, in which students work in the Scientific Writing Course with the first draft of the original

proposal and then the next semester they improve the document before presenting and defending it as part of the Chemistry Graduate Program Seminar Series.

Provide evidence of achievement of program goals and objectives.

The evidence of achievement of program goals and objectives is given by the number of students that have graduated with the knowledge and skills to become independent scientists and researchers, the number of publications, presentations, and approved proposals and fellowships of faculty and students, as well as the number of collaborations in research projects within campus, with UPR units, with other institutions in Puerto Rico, and with institutions abroad. Since time to degree is still too long and the number of required credits too high, we prepared a proposal for the revision of the M.S. and Ph.D. program and the establishment of a M.A. program to not only addres the time to degree issue, but also to update our program to reflect the current educational and research trends observed in other successful Chemistry Programs.

2. **Assessment of Student Learning**

In Appendix 7 we include the current Student Learning Assessment Plan for our program.

a. Planning of the student learning assessment

Evaluate if the Program's Student Learning Assessment Plan shows the following characteristics:

- Is the student learning assessment plan based on the analysis of the program's curriculum map?

  The Student Learning Assessment Plan is based on the analysis of the current curriculum of the program.

- Is the assessment formative or summative?

  We are in the middle of the current three-year Student Learning Assessment Plan. As advised by the campus Coordinator of Student Learning Assessment, we started with a formative assessment. Based on the results of the first year, we were satisfied that the program had fulfilled the assessment evaluation metrics. However, by the last year of the plan, we would implement both formative and summative assessments.

- Is the assessment integrated into the courses? In how many and which courses is it evaluated and with what type of activity, exercise, or task?

  In consultation with the campus Coordinator of Student Learning Assessment we decided to base the assessment of student learning on non-credit requirements, such as thesis proposal, graduate student seminar, original proposal, and thesis/dissertation. Therefore, no assessment integrated with the courses is currently in place. The current assessment is integrated with the activities to fulfill the non-credit

requirements of the program.

- What competencies were included for measurement in the plan?

  For the first year of the assessment plan, the learning domains measured were effective communication, discipline content, research and creation, and critical thinking. For the final two years of the plan, we added to those of the first-year information skills and social responsibility.

- What is the acceptable benchmark or percentage to establish that the student has mastered the measured competency?

  The benchmark to assess if the student masters the measure skill is if the student fulfills or completely fulfills the measured skill. For the program, it is based if 70% of the student fulfills or completely fulfills the measured skill.

- Is it based solely on the use of rubrics or are other forms of assessment included?

  It is all based on the use of rubrics.

- How is the Faculty involved in planning the assessment?

  The Student Learning Assessment Committee of the program informed the faculty of the approved plan and that they would have to complete the rubrics to complete the individual student assessment. At the beginning of each activity in which the student is being assessed, the faculty is reminded that they must complete the rubric and send it to the program coordinator to use it in the student assessment process.

- With how many measures does the assessment cycle close?

  The campus has a policy of a three-year assessment cycle.

- Is the use of the OLAS (Online Learning Assessment System) program to collect assessment measurements included in the plan?

  The plan includes the use of the OLAS programming to gather the assessment data, but we are still in the process of migrating to OLAS.

- Do the assessment plans include a plan to disclose the results?

  The plan includes informing about the results in meetings of the program.

b. Implementation

1. Is the OLAS program used to develop the plan and collect the assessment scores?

   Not yet, but our professors and TAs are being trained on using the OLAS system

so that we can move to use it by the next assessment cycle.

2. How many professors collaborate annually with the appraisal in any facet of the implementation?

   Two professors collaborate in the implementation of the Student Learning Assessment plan (the two members of the Student Learning Assessment Committee of the program).

3. How many students participated in the assessment activities?

   One, Ms. Junellie Cruz, who is the student member of the Student Learning Assessment Committee of the program.

4. What competencies were measured in the program?

   For the first year of the assessment plan, the learning domains measured were effective communication, discipline content, research and creation, and critical thinking. For the second year of the plan, we added to those of the firstf-year information skills and social responsibility.

5. What assessment instruments were used?

   A rubric is used for the assessment of the thesis research proposal, original proposal and thesis presentation and defense. A separate rubric is used for the assessment of the graduate student seminar.

6, Were any unforeseen events during the implementation? Explain.

   Yes, there were unforeseen problems in the implementation of the program. The administrative assistant that helped us with the assessment process retired. In addition, the current pandemic limited our access to campus to gather information from the students' files in the Office of Graduate Studies of the College of Natural Sciences. That made it very difficult to obtain the information needed to complete the first two years of the annual reports.

7. How do the collected measures differ from those that were proposed in the original Student Learning Assessment Plan? Explain.

   They are identical.

8. What do the results of the Student Learning Assessment show?

   The previous student learning assessment plan and the first year of the current assessment plan results indicate that the students have fulfilled the completion of the evaluated skills.

9. How many students managed to reach the benchmark established by the plan for each domain measured? What can the differences be attributed to?

   All students reached the benchmark.

10. Can you detect any relationship between student performance in research and students' critical thinking skills before starting the thesis?

    The students' performance in research is highly correlated with the critical skills before starting to write their theses.

11. Can any possible relationship be detected between student performance in research and factors related to the design and implementation of the curriculum and the program?

    The students' performance in research is highly correlated with the design and implementation of the curriculum and program.

12. What transformative actions - to the program curriculum, to the syllabi and syllabus of the courses, to the training strategies - are proposed as a result of the findings of the assessment of student learning?

    Since for the previous cycle and the first year of the current student learning assessment plan we reached the level of fulfillment established in the plan, we didn't suggest transformative actions. We are finishing the assessment of the second year of the program and will suggest transformative actions if the level of fulfillment established in the plan is not reached.

13. What other factors, not contained in this section, could have contributed or limited the achievement of the expected results?

    The aftermath of: (a) Hurricanes Irma and Maria; (b) the recent earthquake swarm; (c) the COVID-19 pandemic, all of which limited the numbers of students completing the non-credit requirements activities that are measured as part of the assessment plan.

14. What appraisal activities could be carried out in the future to deepen the knowledge of the problems identified or identify with greater certainty other possible factors that contributed or hindered the achievement of the expected results?

    (a) student interviews
    (b) focal groups
    (c) joint discussions about those factors

c. Disclosure

1. Among which constituents was the disclosure of the assessment results carried out? (students, faculty, curriculum committees, departments, external community, etc.).

Faculty.

2. What resulted from the disclosure process that tends to improve the appraisal plans and their learning execution?

N/A.

d. Continuous Improvement: Assessment of the assessment

1. How did the assessment plans and their implementation improve as a product of the analysis and critical reflection at the end of the cycle?

The current three-year assessment plan was improved with respect to the previous five-year assessment plan, which was too ambitious and made the gathering of data difficult. The current plan was the result of several very productive meetings between the Student Learning Assessment Committee and the campus Coordinator of Student Learning Assessment. In addition, the suggestions made were included in the new rubric for graduate student seminars.

II. Curriculum[10] and Learning Experiences

This section guides the analysis of the different components of the curriculum in terms of their effectiveness in achieving the goals, objectives, and profile of the graduate program.

A. Study programs

Provide the study program and curriculum sequence as approved. Adapt the sections according to the structure of your curriculum. The study program specifies the sequence of steps to follow to acquire the knowledge, skills and attitudes that will lead the student to obtain their degree; demonstrates expectations in terms of requirements, sequence, and estimated time for completion. Analysis of the study program compared to the time it takes students to complete their requirements will allow you to make a more realistic assessment of the originally established design vis-à-vis the current operation of the program.

Table 2.1.A. Master's Degree in Chemistry

Graduation Requirements*	Credits
Core Courses: Choose four courses (2 of two areas of specialization) CHEM 6011 - Theory of Inorganic Chemistry I CHEM 6012 - Theory of Inorganic Chemistry II CHEM 6225 - Theory of Instrumental Analysis CHEM 6215 - Theory of Analytical Chemistry CHEM 6411 - Theory of Organic Chemistry I CHEM 6412 - Theory of Organic Chemistry II CHEM 6611 - Advanced Physical Chemistry I CHEM 6612 - Advanced Physical Chemistry II CHEM 6811 - Advanced Biochemistry I CHEM 6812 - Advanced Biochemistry II	12

[10] Curriculum: It refers to the broader framework of learning opportunities, resources, strategies and services that facilitate students to appropriate the personal and professional competencies of their discipline (Rivera, D. 2003).

Requirements in the Area of Specialization: Three group seminar courses are required in their area of specialization (one per semester, I: 1st Sem, II: 2nd Sem.) CHEM 8605 - Seminar of Physical Chemistry I CHEM 8606 - Seminar of Physical Chemistry II CHEM 8005 - Seminar on Inorganic Chemistry I CHEM 8006 - Seminar on Inorganic Chemistry II CHEM 8205 - Seminar of Analytical Chemistry I CHEM 8206 - Seminar of Analytical Chemistry II CHEM 8405 - Seminar of Organic Chemistry I CHEM 8406 - Seminar of Organic Chemistry I CHEM 8801 - Seminar Biochemistry I CHEM 8802 - Seminar Biochemistry II	6
Course as teaching assistants CHEM 6905 - TA CHEM 6906 - TA	2
Graduate seminar CHEM 8901 - Graduate Seminar I CHEM 8902 - Graduate Seminar II Course Continuation of Thesis CHEM 6896 – Master Thesis Continuation	0
Electives in Area of Specialization CHEM 8XXX -	3
Electives	0
Research / Thesis CHEM 8999 - Graduate Research	12
Practice / Internship	0
Total	41

*Includes approving two (2) out of three (3) Qualifying Exams and Proposal A (thesis proposal).

Curricular Sequence

☒Full time ☐ Part time

YEAR 1	
First Semester	**Credits**
Courses/Learning experiences	
CHEM 6905 - TA	3
CHEM 6XXX – Core Course	3
CHEM 6XXX - Core Course	3
Second Semester	**Credits**
Courses/Learning experiences	
CHEM 6906 - TA	3
CHEM 6XXX - Core Course	3
CHEM 6XXX - Core Course	3
CHEM 8999 – Graduate Research	4
CHEM 800X - Group Meetings	2

First Summer	**Credits**
Qualifying Exams (pass two)	0

YEAR 2	
Third Semester	**Credits**
Courses/Learning experiences	
CHEM 8XXX – Elective in Area of Specialization	4
CHEM 8999 – Graduate Research	3

CHEM 8901 – Graduate Seminar CHEM 800X – Group Meetings Present Proposal A (thesis proposal)	1 2
Fourth Semester	**Credits**
Courses/Learning experiences CHEM 8999 – Graduate Research CHEM 8901 - Graduate Seminar CHEM 800X – Group Meetings	 4 1 2

Table 2.1.B. Ph.D. Program in Chemistry

Graduation Requirements	Credits
Core Courses: Choose six courses (2 of three areas of expertise) CHEM 6011 - Theory of Inorganic Chemistry I CHEM 6012 - Theory of Inorganic Chemistry II CHEM 6225 - Theory of Instrumental Analysis CHEM 6215 - Theory of Analytical Chemistry CHEM 6411 - Theory of Organic Chemistry I CHEM 6412 - Theory of Organic Chemistry II CHEM 6611 - Advanced Physical Chemistry I CHEM 6612 - Advanced Physical Chemistry II CHEM 6811 - Advanced Biochemistry I CHEM 6812 - Advanced Biochemistry II	 18
Requirements in the Area of Specialization: Six group seminar courses are required in their area of specialization (one per semester for six semesters, I: 1st Sem, II: 2nd Sem.) CHEM 8605 - Seminar of Physical Chemistry I CHEM 8606 - Seminar of Physical Chemistry II CHEM 8005 - Seminar on Inorganic Chemistry I CHEM 8006 - Seminar on Inorganic Chemistry II CHEM 8205 - Seminar of Analytical Chemistry I CHEM 8206 - Seminar of Analytical Chemistry II CHEM 8405 - Seminar of Organic Chemistry I CHEM 8406 - Seminar of Organic Chemistry I CHEM 8801 - Seminar Biochemistry I CHEM 8802 - Seminar Biochemistry II Course as teaching assistants CHEM 6905 - TA CHEM 6906 - TA Graduate seminar CHEM 8901 - Graduate Seminar I CHEM 8902 - Graduate Seminar II Course Continuation of Doctoral Thesis	 12 6 2
Electives in Area of Specialization CHEM 8XXX -	12
Electives	0
Research/Dissertation CHEM 8999 – Graduate Research	 24
Rotations/Practice/Internship	1
Total	75

*Includes approving three (3) out of three (3) Qualifying Exams and Proposal A (thesis proposal).

Curricular Sequence ☒ Full time ☐ Part time

YEAR 1	
First Semester	**Credits**
Courses/Learning experiences	
CHEM 6905 - TA	3
CHEM 6XXX – Core Course	3
CHEM 6XXX - Core Course	3
CHEM 6XXX - Core Course	3
CHEM 8901 – Graduate Seminar	1
Second Semester	**Credits**
Courses/Learning experiences	
CHEM 6906 - TA	3
CHEM 6XXX – Core Course	3
CHEM 6XXX - Core Course	3
CHEM 6XXX - Core Course	3
CHEM 8902 – Graduate Seminar	1
CHEM 8XXX - Seminar in the Area of Specialization (Group Meetings)	2
First Summer	**Credits**
Qualifying Exams (pass three) and start research	0

YEAR 2	
Third Semester	**Credits**
Courses/Learning experiences	
CHEM 8XXX - Seminar in the Area of Specialization (Group Meetings)	2
CHEM 8999 – Graduate Research	
CHEM 8XXX- Elective Course	3
Present graduate seminar	3
Fourth Semester	**Credits**
Courses/Learning experiences	
CHEM 8XXX - Seminar in the Area of Specialization (Group Meetings)	
CHEM 8999 – Graduate Research CHEM 8XXX- Elective Course	2 3
Second Summer	**Credits**
Continuation of research	0

YEAR 3	
Fifth Semester	**Credits**
Courses/Learning experiences	
CHEM 8XXX - Seminar in the Area of Specialization (Group Meetings)	2
CHEM 8999 – Graduate Research	3
CHEM 8XXX- Elective Course	3
Present Proposal A (thesis proposal)	0
Sixth Semester	**Credits**
Courses/Learning experiences	
CHEM 8XXX - Seminar in the Area of Specialization (Group Meetings)	2
CHEM 8999 – Graduate Research	6
CHEM 8XXX- Elective Course	3

Present Proposal B (original proposal)	0
Third Summer	**Credits**
Continuation of research	0

YEAR 4	
Seventh Semester	**Credits**
Courses/Learning experiences	
CHEM 8XXX - Seminar in the Area of Specialization (Group Meetings)	2
CHEM 8999 – Graduate Research	9
Eight Semester	**Credits**
Courses/Learning experiences	
CHEM 8896 - Continuation of the Doctoral Thesis	0
Dissertation Defense	0
Fourth Summer	**Credits**

The curriculum and learning experiences were evaluated through a survey that was answered by 57 participants, including three populations of the Chemistry Graduate Program: (i) current students (62% of the respondents), (ii) alumni (26% of the respondents), and (iii) faculty (12% of the respondents). Two main questions were asked at the beginning of the curriculum section of the survey to assess the level of satisfaction regarding (a) the skills and knowledge necessary to perform successfully in their future careers, and (b) whether the program provides them with the training to successfully complete the thesis and/or dissertation. 69% of the students currently in the program agree or strongly agree that the curriculum and the co-curricular experiences of the program provides them with the skills and knowledge necessary to perform successfully in their future careers; this value increases to 73% and 86% for the alumni and faculty populations, respectively. 67% of the students currently in the program agree or strongly agree that the curriculum and the co-curricular experiences of the program provides them with the training to successfully complete the thesis and/or dissertation; this value increases to 73% and 86% for the alumni and faculty populations, respectively. 72% of the students currently in the program say that the breadth and diversity of the curriculum and the co-curricular experiences of the program are good or excellent; this value changes to 60% and 100% for the alumni and faculty populations, respectively. 86% of the students currently in the program say that the level of depth in the specialty courses of the program is good or excellent; this value increases to 100% for the alumni and faculty populations. 73% of the students currently in the program say that the quality of training in the ethical aspects of the area of specialty of the program are good or excellent; this value increases to 73% and 86% for the alumni and faculty populations, respectively. 58% of the students currently in the program say that the quality of their experience as teaching assistants in the program is good or excellent; this value changes to 47% and 57% for the alumni and faculty populations, respectively.

In terms of the number of credits and requirements of the program, 47% of the alumni population believe it is satisfactory; this percentage drops to 36% among current students in the program (see survey of students in Appendix 2) and between faculty only 29% is satisfied

with the number of courses' credits required (see faculty survey in Appendix 4). 69% of the students currently in the program say that the number of admission requirements of the program are good or excellent; this value changes to 67% and 86% for the alumni and faculty populations, respectively. 56% of the students currently in the program say that the frequency with which the required courses were offered is good or excellent; this value changes to 53% and 71% for the alumni and faculty populations, respectively. 86% of the students currently in the program say that the convenience of the courses' schedule is good or excellent; this value changes to 80% and 57% for the alumni and faculty populations, respectively. 57% of students currently in the program say that they are satisfied with the qualifying exams as a measure of a student's ability to pursue graduate studies at Master's level or Ph.D. Among professors, 57% say the qualifying exams are necessary to develop critical thinking and the ability for independent study and research, while 60% of the alumni expressed to agree with this statement.

B. Courses and Learning Experiences (Curriculum Design Matrix)

The learning objectives of the program (general objectives) are broken down into course objectives and other curricular experiences (specific objectives). Fill in the “Learning Objectives” column with the general learning objectives and order them from the simplest to the most complex according to Bloom's Objectives Taxonomy. Check objectives that involve research / creation skills or critical thinking in the far-left columns.

Write in the "Specific Objectives" columns the courses and / or experiences of your program, from left to right in the order of the curricular sequence. Finally, mark the courses and experiences according to how your syllabi respond to the general learning objectives. This will allow you to make a visual analysis of the curricular alignment, perceive the order in which the objectives were arranged in the curriculum and detect gaps or misalignment in the design.

Table 2.2.B.

Research	Critical thinking		Specific Objectives											
			COURSE CHEM 6011	COURSE CHEM 6225	COURSE CHEM 6411	COURSE CHEM 6611	COURSE CHEM 6811	COURSE CHEM 6012	COURSE CHEM 6215	COURSE CHEM 6412	COURSE CHEM 6612	COURSE CHEM 6812	COURSE CHEM 6905-06 (TA)	COURSE CHEM 8901-02 (Grad Sem.)
☐	x	1. To demonstrate mastery of the fundamental concepts of chemistry	X	X	X	X	X	X	X	X	X	X	X	X
x		2. To demonstrate knowledge of the scientific instrumentation as supporting tools in solving chemical problems.												
☐	x	3. Demonstrate technical capacity to make presentations to a diverse scientific community in Spanish and English.						X		X			X	X
☐	x	4. Demonstrate interpersonal relations skills and teamwork with people from diverse cultural backgrounds.						X						
☐	x	5. Demonstrate ability to keep up their self-taught knowledge through continuous learning.						X		X				
☐	x	6. Handle correctly the scientific literature to support the solution of chemical problems.	X		X			X		X			X	X

x	x	7. Write publishable research documents (articles and a dissertation) in English and Spanish.											X	X
☐	x	8. Integrate the concepts of chemistry to solving theoretical and practical problems that require an interdisciplinary approach.						X		X	X		X	X
☐	x	9. Integrate and effectively convey the fundamental concepts of chemistry using different forms of teaching to various groups.						X					X	X
☐	x	10. Identify and implement occupational safety standards and discipline typical of environmental protection												
☐	x	11. Follow ethical behavior in their academic and professional performance.						X					X	X
x	x	12. Identify a chemical problem, formulate a working hypothesis, and discriminate between the possible strategies to address it.						X						
x	x	13. Design and assemble an experiment, collect and analyze information and identify sources of error, and interpret the results.											X	X

C. Curriculum Content and Review

a. Is the **curricular content**[11] fundamented in the research results and theoretical concepts of that content conducted by the scientific community of the discipline?

Yes, according to the alumni survey, only 7% expressed dissatisfaction with the preparation offered by the Program for success in their professional careers. Therefore, the external scientific community that evaluates and recruits them for jobs in industry, government or academia understand that the curricular content of our Program is a solid one that prepares our alumni satisfactorily.

b. Has the curricular content been revised by peers?

The curricular content has been peer-revised in the previous external evaluation of the graduate program (as part of the previous Self-Study of the program).

c. Does the content reflect the ethical, legal, and regulatory normatives and standards that impact the related field of studies?

Yes, the content partially reflects those guidelines and standards, since according to the alumni survey, 73% of them express that the quality of the ethical training in the curriculum is satisfactory or very satisfactory.

d. When was the last curricular revision of the Program? January/2021

1. How adequate the curriculum has demonstrated to be for the accomplishment of the development of the competencies included in the alumni profile?

   Yes, the curriculum has been adequate for accomplishing the development of the competencies included in the alumni profile.

   Recently, we approved at the program, department, and college level, a proposal for the revision of the M.S. and Ph.D. program as well as a proposal for the establishment of a new M.A. in Chemistry program (with no thesis requirement). We hope that those proposals will be approved at the campus level this semester and if so, we might be able to implement the new curriculum by August 2021.

2. What data demonstrates that the curriculum is adequate in terms of amplitude, depth, and the level of the discipline?

   According to the alumni survey, the diversity of the areas in which our alumni currently work give evidence that the amplitude, depth, and the level of the curriculum is adequate. In addition, the interdisciplinarity of the research that our students are involved, provide them with the amplitude and depth to prepare them for their future careers.

e. Have there been changes or significant innovations or are any foreseen in the areas of study of the Program since the last curricular revision. Is there has been, are these changes reflected in any form in the **study program** (Table 2.1.A.) or the academic offer (Section II.F) of the Program?

[11] Curriculum content refers to the knowledge in the curriculum.

The last curricular revision contributed to make students get involved in research earlier in their graduate career through the Proposal A (thesis proposal) requirement and to initiate them into bibliographic search in the scientific literature. The Proposal A requirement is named now the Research Plan Proposal in the proposed revision of the Chemistry Graduate Program. Since 2016, a formal rotation process was established for new graduate students that counts for one credit for research done during their exploration period in the host laboratories. However, in the new proposal for revision of our Chemistry Graduate Program, the rotations continue, but on a voluntary basis. In addition, a Scientific Writing course that has been offered for the last two years as an Special Topics course will become an official requirement of the program. At the M.S. and M.A. level, the revision includes that no qualifying exam or candidacy exam will be required, and at the Ph.D. level the current qualifying exam requirement is replaced with a candidacy exam. Finally, the current Proposal B requirement (original proposal) will be replaced with an original research proposal for which the student will write the first draft of the document as part of the Scientific Writing course under the supervision of the course professor, and then during the next semester the student will finish the final version of the document to present and defend it as part of the Graduate Seminar Series.

f. Are there any important areas of study that the Program wishes to address? Can these areas of study be taken care of by minimal changes in the curriculum or do they required a full curricular revision? If so, what measures the Program needs to take to renew the curriculum?

Recently, we approved at the program, department, and college level, a proposal for the revision of the M.S. and Ph.D. program as well as a proposal for the establishment of a new M.A. in Chemistry program (with no thesis requirement). We hope that those proposals will be approved at the campus level this semester and if so, we might be able to implement the new curriculum by August 2021. The new revision includes the changes required to renew the curriculum.

g. Demonstrate with the graduation rate of the last 5 years that the students could complete the program in the time established.

Figures 2 and 3 shows the graduate rate for the last 5 years for the M.S. and Ph.D. tracks.

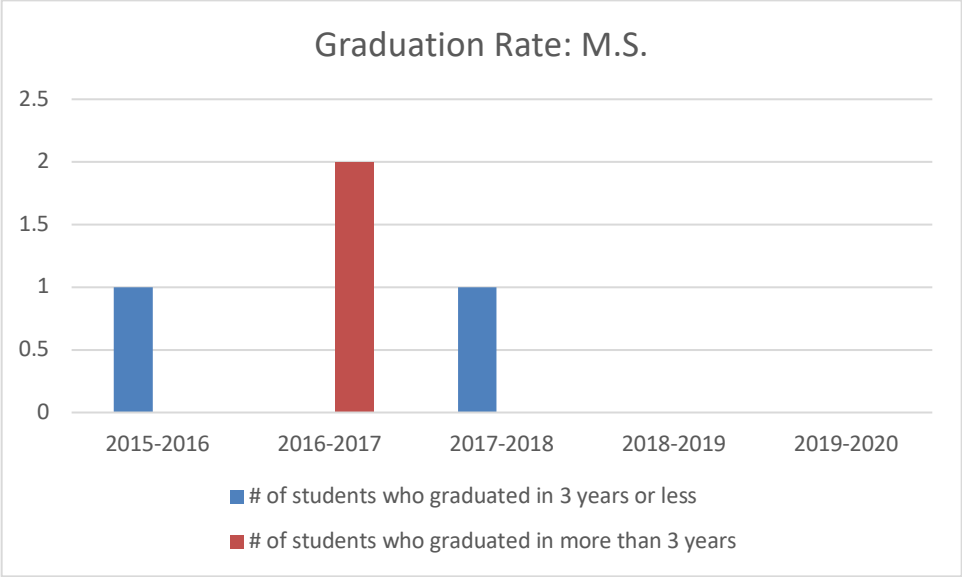

Figure 2. Master's Program Graduation Rate.

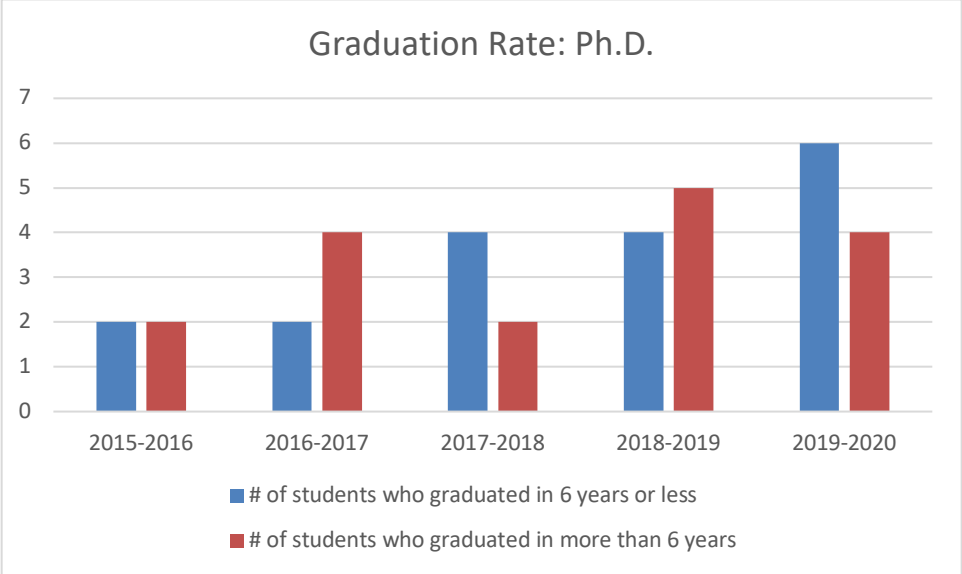

Figure 3. Doctoral Program Graduation Rate

h. What percent of students are able to complete the course sequence in the time established for the program?

The Figure 4 shows the percentage of student that completed the course sequence in the time established for the Ph.D. track.

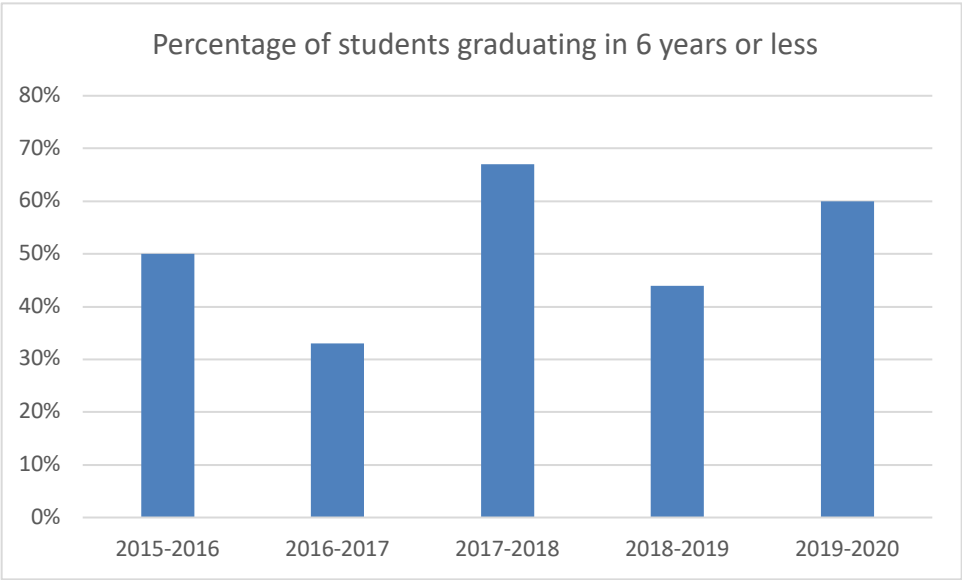

Figure 4. Percentage of students graduating in 6 years or less

i. How effective has been the teaching methodology used to impart the program curriculum? How is it evidenced?

The program has been very effective in imparting knowledge and skills through its curriculum as evidenced by the Self-Study survey. 69% of the student who answered the survey agree or strongly agree that the curriculum provided the knowledge and skills required for the discipline. In addition, 67% of the student who answered the survey agree or strongly agree that the curriculum provides the training to complete the thesis, dissertation, or related project.

j. What complementary activities have been conducted during the last five years to strengthen the program curriculum?

In the Graduate Seminar Series of the Chemistry Graduate Program, seminars and professional development workshops have been carried out, special topic courses have been updated to cover emerging areas in the discipline. On the other hand, the Graduate Association of Chemistry, in its self-management to complement the program, has carried out activities outside the classroom that directly strengthen the curriculum, such as visits to pharmaceutical and biotechnology plants. The association has also conducted peer mentoring services among its members.

D. Admission Requirements

Mark with an (X) the requirements that your Program requires.

Table 2.3. D.

Admission Requirements	Chemistry MSc/Ph.D
Academic Index (Minimum 3.0 GPA)	☒
Entrance exam	☐
PAEG	☐
GRE	☐
Admission Essay	☒
Interview (optional)	☒
Recommendations	☒
Professional Experience	☐
Research Experience (optional)	☒
Other:	☐

a. Are the admission requirements adequate to identify suitable candidates for the program? Can it be documented how the predictive value of these requirements is determined in predicting optimal student performance and retention in the program?

   Yes. Admission requirements are adequate to identify suitable candidates for the program, particularly research experience, letters of recommendation and the admissions essay.

b. How lax or demanding are the admission requirements of the Program?

   The admission requirements are the usual ones for chemistry graduate programs in the US. Admission requirements of the program are lax. We do conditional admissions if the student has not submitted all the documents required for admission and if they have an academic index slightly below the required one but their other documents show a high probability that the student will be successful.

c. Is the preparation of students who meet these admission requirements adequate for the level of requirement of the Program?

   Yes. Although we have recently identified that some students admitted to the program have some basic knowledge gaps. The program plans to offer more mentoring services (both from faculty and fellow advanced graduate students) to entering students to help them adapt to the level of requirement of the program.

   Most of the students enrolled are prepared to meet the requirements of the program judging by the retention and graduation data. Few students (less than 10%) fall on

probation each year.

d. Does the Program require a baccalaureate degree in the same discipline of study as the Program to pursue graduate studies?

Although most of the students admitted to the program have a B.S. in Chemistry degree, students do not need to have a bachelor's degree in Chemistry to be admitted, but students with equivalent degrees and requirements in Chemistry may be admitted. Students must have completed the required courses in a course sequence of a Bachelor's degree in Chemistry or equivalent.

- Do the initial courses start with the premise that a bachelor's degree is needed to take them or, conversely, result in knowledge that the student should have already acquired? What impact do these required courses have on the time to complete the degree? Explain, if applicable.

  Although the initial courses are the core courses in chemistry, the professors make efforts to bring the group to the required level, irrespective of their institutional background. This may include some reviews of material, tutoring by professors, and even workshops.

  Since our core courses are taken by all entering graduate students during their first year in the program, they have no impact on their time-to-degree.

- Do the requirements of initial courses or previous degrees start from the requirements of the accrediting agency or another that establishes the quality parameters for the disciplines or fields of study? Explain, if applicable.

  There is no accrediting agency for graduate programs in Chemistry. However, core courses in the basic areas of chemistry for first year graduate students is a common practice among chemistry graduate programs.

- Does the program include courses and / or graduation requirements to compensate for the lack of a baccalaureate in the discipline? Explain, if applicable.

  No.

e. Is there a course (e.g., statistics or specialized course) that the student must have as a prerequisite to be able to study in the graduate program under evaluation? Explain, if applicable.

□ Yes. Are these prerequisites still necessary?? ☒No

E. Graduation Requirements

Mark with an (X) all graduation requirements required by the Program.

Table 2.4.E.

Graduation Requirements	Program under evaluation
Minimum Academic Index (GPA)	☒
Required credits	☒
Proposal A and Proposal B	☒
Candidacy Exam (Qualifying Exam)	☒
Research project	☒
Thesis / Dissertation	☒
Practice	□
Residency[12]	□
Internship	□

a. Are the **graduation requirements** aligned with the **overall learning objectives** of the program? Do the **graduation requirements** serve their purpose, that is, do they facilitate or hinder the achievement of **learning objectives**? (See Table 2.2.B, Courses and Learning Experiences)

Yes, the graduation requirements are aligned with general learning objectives and facilitate their achievement. Nevertheless, the Program has conducted a revision of the program's curriculum in response to the previous Self-Study results that has led to changes in graduation requirements to comply with Certification No. 95 of the Academic Senate, Academic Year 2019-2020.

b. Is the selection and organization of **graduation requirements** the most appropriate to facilitate the learning objectives or could the same purposes be fulfilled by other, more efficient means? (See Table 2.2.B, Courses and Learning Experiences)

Yes, and the Program has conducted a revision of the program's curriculum in response to the previous Self-Study results that has led to changes in graduation requirements to comply with Certification No. 95 of the Academic Senate, Academic Year 2019-2020.

c. Does the Program provide some flexibility to meet the requirements of the degree? That is, can the student choose between alternative study tracks (research / creation or professional) or substitute requirements for equivalent work? Explain.

No. The program is designed for students to have an experience attached to a research laboratory and cannot be provided by a professional experience or an equivalent job. However, in the recently conducted revision of the program the students can substitute some requirement credits with internship experiences in external laboratories.

d. Curricular options are offered, institutionally approved, to complete the requirements of the Doctorate degree in less time (e.g., Master-PhD. Path)? Explain.

[12] Use information from course evaluations.

N/A, because the program offers the option to enter directly to the Doctoral program without completing a Master's. Although we offer a M.S. in Chemistry program and a Ph.D. in Chemistry program, students don't need to complete a M.S. in Chemistry degree before entering the Ph.D. in Chemistry program.

e. Do all the **degree requirements** have guidelines, syllabi or manuals that explain the procedures, expectations, and criteria for evaluating them? Are these manuals approved by program members?

Yes, they are included in the Regulations for the program that were approved by all program members.

f. Is a protocol or itinerary defined somewhere for the development of the different phases of the thesis / dissertation work and for the roles of the mentor and the student? Are these protocols approved by program members and students?

Yes, they are included in the Regulations for the program that were approved by all program members.

F. Curriculum Design Analysis

a. Does the program have a full-time and a part-time curricular sequence?

□ Yes ☒ No, it only has one for _____full_____ time

¿Does this design meet the needs of the students?

The recently conducted revision of the program includes a full-time and a part-time curricular sequence to meet the needs of the students.

b. How might the design or ordering of the **curriculum sequence** affect the time it takes for the student to complete their degree requirements?

In terms of the approval of courses, students meet the stipulated time to meet those requirements. However, some non-credit requirements such as Proposal B has lengthened the time to meet those requirements. The recent curriculum revision should reduce the time it takes for the student to complete all their degree requirements.

c. What can be observed in the table of Courses and Learning Experiences about the distribution and sequence of the courses and requirements? Can you identify any patterns? Are the learning objectives met in a relatively orderly manner? Are there gaps?

The sequence of courses is distributed with core courses in the first year, which are requirements for specialty courses, that are taken from their second year in the program on. The implementation of the next development plan will help students to plan ahead their curriculum with at least two years in advance.

The graduate program recently approved the designation of two professors as graduate academic counselors to help student better organize and meet degree requirements.

d. Is the distribution of the curriculum **content**[13] appropriate? That is, do core courses include all the knowledge and skills that are essential?

   The core courses do not include all the knowledge and skills that are essential, but they do include the main ones. It is understood that students enter with substantial fundamental knowledge. Specialty courses built on the knowledge and skills acquired in the core courses and contain a heterogeneous distribution of essential knowledge of the discipline.

e. Do the core courses have a level of complexity appropriate to the degree for which they are offered (Master's or Doctorate)?

   The core courses are the same for M.S. and Ph.D. students and have the appropriate level of complexity. This is because graduate students in both the M.S. and Ph.D. levels must have the same basic knowledge.

f. Do the courses created for the selection of free electives contribute to the content of the specialty or is it only tangential knowledge?

   The Special Topic courses which are offered as advanced courses and free electives contribute to the content of the specialty. Some of them are so vital that are being considered to become part of the regular curriculum of the program.

g. Is the relationship between admission requirements and degree requirements adequate to promote a satisfactory and efficient performance of students in the program? In what way does the relationship between the two requirements make it easier or more difficult to obtain the degree?

   Most of the students enrolled are prepared to meet the requirements of the program judging by the retention and graduation data. This implies an adequate relationship between admission requirements and degree requirements conducive to a satisfactory performance in the program, facilitating obtaining the degree.

h. What is the relationship (if any) between the research / creation generated in the Program and the curriculum design? Is it the curricular design that guides the lines of research / creative work, or vice versa?

   There is no direct relationship between research in the program and curriculum design in the core and regular advanced courses, but the Special Topics courses arise from the research interests of professors.

i. How does the curriculum promote interdisciplinary knowledge and learning?

   Emerging research topics presented in the courses encourage students to consider interdisciplinary scenarios. Graduate seminars provide exposure to issues and interdisciplinary knowledge that students subsequently apply in their research.

[13] Use information from course evaluations.

There are internship opportunities in external research centers that provide expertise and co-curricular interdisciplinary learning experiences. Existing collaborations between local and external researchers promote interdisciplinary learning.

The program promotes participation in scientific conferences to expose and develop in student's knowledge and interdisciplinary learning. The next 5-year development plan and curriculum review seeks to cross boundaries of disciplines in all areas of science.

j. Does the curriculum and learning experiences provide opportunities to the student for the development of competencies in information technology (search, information management, selection, synthesis) allow him to broaden his vision and deepen the study of his discipline?

The curriculum and learning experiences attend information skills and knowledge of the latest technology in the discipline. The Library of the Faculty of Natural Sciences offers information skills workshops that promote the development of skills in search and information management. Graduate seminars allow students to select and synthesize the information gathered.

k. How does the curriculum promote ethical behavior in the student?

Students take a workshop on ethics in the guidance and training activity that all new students take before starting their first semester in the program. The workshops on safety and waste management also allow students to develop social and civic awareness.

Many of the research projects in the program attend current social problems.

l. In what form does the curriculum provide for the student to develop the necessary skills to perform in work settings accessible to future graduates of the Program? Does the curriculum provide for an internship or internship experience?

The curriculum provides students with the necessary knowledge and laboratory skills necessary to perform adequately in work settings accessible to them as future graduates of the program. However, the curriculum does not provide students a formal internship course that would allow them to participate in internship experiences in laboratories at academic and industrial settings in Puerto Rico and abroad. Nevertheless, many of the research programs offer students the opportunity of internship experiences in national research laboratories and in academic laboratories abroad.

m. In what way does the curriculum provide the means for the student to acquire the skills and attitudes that allow him/her to be a productive and creative professional that contributes to the development of his/her discipline of study?

Special Topics courses usually have as requirement the development of a research proposal or a publication in a peer-reviewed journal, which promote productivity and creative professional work that contributes to the development of the discipline of study. One of the requirements of the curriculum is for students to present their findings at conferences and publish in refereed journals contributing to the development of their

discipline. The requirement of Proposal B stimulates creativity in the development of a distinct solution to a research problem.

n. Does the program adequately prepare students to pass certification or revalidation exams? (If applicable) What is evidenced by the data on the achievements of the program graduates in said external tests?

Not Applicable

G. Academic Offer

List the courses offered in the academic years indicated in the table below. In the classification column mark with an (X) as appropriate.

Table 2.5.F.*

Academic Year	Course Codification	Classification		% of drops in core courses	Number of Sections	Course Schedule (Check one)			
		Core	Elective			Morning	Evening	Night	Saturdays
2015-2016	Q-6011, Q-6012, Inorganic Chemistry Theory I &II Q-6225, Q-6215 Analytical Chemistry Theory I&II Q-6411, Q-6412, Organic Chemistry Theory I& II Q-6611, Q-6612, Advance Physical Chemistry Q-6811, Q-6812 Biochemistry I &II	x		9%	1	x			
2016-2017	Q-6011, Q-6012, Inorganic Chemistry Theory I &II Q-6225, Q-6215 Analytical Chemistry Theory I&II Q-6411, Q-6412, Organic Chemistry Theory I& II Q-6611, Q-6612, Advance Physical Chemistry Q-6811, Q-6812 Biochemistry I &II	x		16%	1	X			
2017-2018	Q-6011, Q-6012, Inorganic Chemistry Theory I &II Q-6225, Q-6215 Analytical Chemistry Theory I&II Q-6411, Q-6412, Organic Chemistry Theory I& II Q-6611, Q-6612, Advance Physical Chemistry Q-6811, Q-6812 Biochemistry I &II	x		12 %	1	X			
2018-2019	Q-6011, Q-6012, Inorganic Chemistry Theory I &II Q-6225, Q-6215 Analytical Chemistry Theory I&II Q-6411, Q-6412, Organic Chemistry Theory I& II Q-6611, Q-6612, Advance Physical Chemistry Q-6811, Q-6812 Biochemistry I &II	x		25%	1	X			
2019-2020	Q-6011, Q-6012, Inorganic Chemistry Theory I &II Q-6225, Q-6215 Analytical Chemistry Theory I&II Q-6411, Q-6412, Organic Chemistry Theory I& II Q-6611, Q-6612, Advance Physical Chemistry Q-6811, Q-6812 Biochemistry I &II	x		8%	1	X			

* Percent of students that dropped the core courses. The percent was calculated using the total of students enrolled in all the core courses each year.

1. **Courses that make up the curriculum**

    a. Evidence that the course syllabi are kept up to date and fully comply with the requirements of Certification 42 (2019-2020) of the Governing Board, Guide for the registration and uniform coding of courses.

    The general course syllabi are kept up to date and comply with the requirements of Certification 42.

    b. Has the content of the courses of the program maintained the expected tangency with the alumni profile?

    Yes.

    c. What efforts does the program make to create or modify courses under different modalities (in-person, hybrid, distance, online)

    The current COVID-19 pandemic forced the program to conduct all courses online. We have not created online courses, just modified the current in-person courses to give them online. Now that professor have had the experience of offering online courses and received training on preparing them, we expect the creation and modification of other graduate courses in hybrid, distance, and online modalities.

    d. Is there harmony in the information of the updated description of the courses between the various sources where it is disclosed?

    Yes.

2. **Course offer**

    a. Are the courses - requirements and electives - offered at the times and the frequency or regularity necessary to support the academic progress of the students and complete the program in the time established in the institutional policy?

    At the 6000 level, cores courses are offered every semester. At the 8000 level, the majority are offered in alternate years. However, 56% of the current students and 53% of the alumni that answered the survey conducted as part of this Self-Study answered that the frequency of the required courses is either excellent or good.

    b. What courses in the sequence have not been offered in the past five years and what have been the reasons?

    All the courses in the sequence are offered regularly, but some Special Topics courses have not been offered with the same frequency, some due to recent retirements.

    c. Are required courses and targeted electives offered according to the curricular sequence?

    Yes.

d. How does the course offer meet the needs and number of students?

The academic offer considers the needs and number of students in the program. We have enough core courses and specialized courses to fulfill our student body needs.

e. Indicate the number of courses created, modified, eliminated, and on moratorium per academic year in the following table:

Table 2.6.G.

Academic Year	Creates	Modified	Eliminated	Moratorium
2015-2016	0	0	0	0
2016-2017	0	0	0	0
2017-2018	0	0	0	0
2018-2019	0	0	0	0
2019-2020	0	0	0	0

a. What is the demand for courses from this Program by students from other Programs in the Campus? How does the Program attend to this demand?

Students from the Chemical Physics graduate program regularly take our Physical Chemistry courses. In addition, students in the Environmental Sciences graduate program take some of our courses. The program can attend this demand.

b. How regularly does the Program evaluate the courses it offers?

☐ Semi-annually
☐ Annually
☒ In curricular reviews
☐ As a result of the self-study process
☐ Has not been done so far

c. From the results of the evaluation of courses by students, what do you think about their content and quality, the teaching and learning processes and the performance of the professors under the modality that applies (in-person, hybrid, distance, online)?[14]

There is still no Program-wide procedure for the evaluation of all courses by students, but the survey conducted as part of this Self-Study included a question about this matter.

Each individual professor can use their own student evaluation rubric and administer it at the end of their course. The next development plan includes that all divisions in the Program will embark in an evaluation of their courses, which will include course evaluations by student.

[14] Use information from course evaluations.

III. Professors / Researchers

A. Profiles of Program Professors

In the following table, write the names of the professors of the Program and their academic preparation (including the institution and the year of graduation for the highest degree obtained). Indicate with an (X) in the corresponding column if the teacher is attached to the Program or is a collaborator through a task shared with another unit, Ad-honorem work, among other ways. Also indicate the specialty you teach, the years of service, the courses you offer regularly, and the number of supervised theses / dissertations or master's and doctoral projects in the last (5) years. In the last column, mark with an (X) those professors of international origin.

Table 3.1.A.

Name of the Professor	Academic Preparation	Status		Specialty	Research areas	Years of service	Courses regularly offered	Quantity of supervised theses	International origin
		Collaborator	Member						
Carlos Cabrera	Cornell University, 1987		x	Nanotechnology & Analytical Chemistry	Nanomaterials for alkaline fuel cells. Dye sensitized solar cells. Microbial Fuel Cells and nanobiosensors.	31	CHEM -5995 Introduction to Nanotechnology CHEM -6225, CHEM-6215 Analytical Chemistry Theory I&II CHEM8205-CHEM8206 Analytical Chemistry Seminar	10	

Name of the Professor	Academic Preparation	Status		Specialty	Research areas	Years of service	Courses regularly offered	Quantity of supervised theses	International origin
		Collaborator	Member						
Néstor M. Carballeira	University of Würzburg, 1983		x	Organic Chemistry and Medicinal Chemistry	Lipid Chemistry and Marine Natural Products: Isolation and Synthesis of New Fatty Acids of Marine Origin; New Antiplasmodial and Antifungal Lipids.	35	CHEM-5995 Medicinal Chemistry CHEM-6411, CHEM6412, Organic Chemistry Theory I& II CHEM-8405-CHEM 8406 Organic Chemistry Seminar I & II	1	
Zhongfang Chen	Nankai University, 2000		x	Thermodynamics Molecular Structure and Chemical Bonding Computational Chemistry	Computational chemistry, computational nanomaterials science, physical organic chemistry.	12	CHEM-4041 Intermediate Physical Chemistry CHEM-8996-013 Advanced Scientific Writing CHEM-6611, CHEM-6612, Advance Physical Chemistry CHEM-8605-Chem 8606 Physical Chemistry seminar	4	x

Name of the Professor	Academic Preparation	Status		Specialty	Research areas	Years of service	Courses regularly offered	Quantity of supervised theses	International origin
		Collaborator	Member						
Jorge Colón	Texas A&M University, 1989		x	Inorganic Chemistry	Inorganic, bioinorganic, and materials chemistry; Layered inorganic compounds; Electrocatalysis of OER; Amperometric biosensors; Drug delivery systems; Photophysics and photochemistry of luminescent metal complexes.	27	CHEM-4000 Intermediate Inorganic Chemistry CHEM-6011, CHEM-6012, Inorganic Chemistry Theory I &II Q-8005 Inorganic Chemistry Seminar	1	
Kai Hans Griebenow	MIT, 1996 University of Duesseldorf, 1992		x	Biochemistry	Structure-guided protein encapsulation, non-aqueous enzymology, protein formulation, protein stability, protein glycosylation, relationship between protein structural dynamics and enzyme activity, PEG modification of proteins, bio-fuel cells.	20	CHEM 4025 Biochemistry CHEM-6811, CHEM-6812 Biochemistry I &II CHEM-8801-CHEM8802 Biochemistry Seminar I & II	3	x
Ana R. Guadalupe Quiñones	University of North Carolina at Chapel Hill, 1998		x (Retired 2020)	Analytical Chemistry	Analytical Chemistry-Electrochemistry: Chemical Sensors and Biosensors; Uses of Immobilized Enzymes; Polymer.	31	Q-3255 Quantitative Analytical Chemistry CHEM -6225, CHEM-6215 Analytical Chemistry Theory I&II CHEM8205-CHEM8206 Analytical Chemistry Seminar	2	

Name of the Professor	Academic Preparation	Status		Specialty	Research areas	Years of service	Courses regularly offered	Quantity of supervised theses	International origin
		Collaborator	Member						
Ingrid Montes	UPR-RP, 1985		x	Organic Chemistry	Organometallic chemistry Chemical education	33	CHEM-3451 -3452 Organic Chemistry for majors I & II CHEM-8405 Organic Chemistry Seminar I&II	1	
Edwin Quiñones	University of Puerto Rico, 1986		X (Retired 2020)	Physical Chemistry	Kinetic studies of enzymes engaged in DNA metabolism at the single-molecule level, protein folding, DNA mechanical properties, fluorescence spectroscopy and laser spectroscopy of small molecules.	30	CHEM 6611-CHEM 6612 Advance Physical Chemistry I & II CHEM4041-CHEM4042-Intermediate Physical Chemistry CHEM-8605-Chem 8606 Physical Chemistry seminar	1	

Name of the Professor	Academic Preparation	Status		Specialty	Research areas	Years of service	Courses regularly offered	Quantity of supervised theses	International origin
		Collaborator	Member						
Abimael D. Rodríguez	The Johns Hopkins University, 1983			Spectrometric Identification of Organics Compounds Organic Chemistry	Organic Chemistry: Isolation, Structure, Elucidation and Synthesis of Marine Natural Products.	33	CHEM-4025-Spectroscopy CHEM3031-CHEM3032-General Organic Chemistry CHEM-6411, CHEM-6412, Organic Chemistry Theory I & II CHEM-8405-CHEM 8406 Organic Chemistry Seminar I & II	1	
Brad Weiner	University of California, 1986			Physical Chemistry	Physical Chemistry: Gas Phase Molecular Reaction Dynamics; Laser Photochemistry and Photophysics; Gas Phase Kinetics of Reactive Intermediates; Non-Linear Photoprocesses; Molecular Energy Transfer; Mechanisms of Laser Ablation.	32	CHEM-3001 General Chemistry CHEM4041-CHEM4042 Intermediate Physical Chemistry CHEM-8605-Chem 8606 Physical Chemistry seminar	1	

Name of the Professor	Academic Preparation	Status		Specialty	Research areas	Years of service	Courses regularly offered	Quantity of supervised theses	International origin
		Collaborator	Member						
Dalice M. Piñero	UPR-RP, 2009			Coordination Chemistry	Synthesis of metal complexes and multidimensional networks for their application in Materials Science and Nanomedicine.	11	Q-6011, Q-6012, Inorganic Chemistry Theory I & II CHEM5995- Inorganic Chemistry Laboratory CHEM8990- cristalography Q-8005 Inorganic Chemistry Seminar CHEM-8901- CHEM 8902 Graduate Seminar I & II	1	
Liz M. Díáz Vázquez	UPRRP, 2005			Chemical Education, Environmental Chemistry Renewable energy & Sustainability	Improvement of Science communication and research skills of undergraduate and graduate students Environmental metabolomics of emerging contaminants and sustainable methods for the development of nanomaterials	15	CHEM-6905, Q-6906 principles and practices of chemistry CHEM4015- Instrumental Analysis CHEM3255- Analytical Chemistry CHEM5995- Forensic Chemistry CHEM8205-CHEM8206 Analytical Chemistry Seminar	1	

Name of the Professor	Academic Preparation	Status		Specialty	Research areas	Years of service	Courses regularly offered	Quantity of supervised theses	International origin
		Collaborator	Member						
Eduardo Nicolau	UPR-RP, 2012			Analytical applications of bio-nanomaterials	Preparation of interfaced bionanomaterials for reactive water purification membranes; Development of point-of-use sensors for the detection of emerging contaminants in water; Synthesis and characterization of nanomaterials for electrooxidation of high-density fuels; Development of analytical methodology through chemometrics.	6	CHEM4015L-Instrumental Analysis Laboratory CHEM-6225, CHEM-6215 Analytical Chemistry Theory I &II CHEM8205-CHEM8206 Analytical Chemistry Seminar	2	
Vilmali López	University of Michigan-Ann Arbor. 2011.			Analytical Chemistry	To design heteronucleation platforms for three major crystallization efforts: to gain understanding of the fundamental factors that affect nucleation in molecular compounds, to promote or inhibit heterogeneous nucleation in chiral and achiral compounds, and to access, stabilize and deliver pure thermodynamically unstable solid-forms and/or pure enantiomers of pharmaceuticals, energetic materials, and electronic materials for novel applications.	6	CHEM4015L-Instrumental Analysis Laboratory CHEM 3255-Quantitative Analytical Chemistry CHEM-6225, CHEM-6215 Analytical Chemistry Theory I & II CHEM8205-CHEM8206 Analytical Chemistry Seminar	1	

Name of the Professor	Academic Preparation	Status		Specialty	Research areas	Years of service	Courses regularly offered	Quantity of supervised theses	International origin
		Collaborator	Member						
José A. Prieto	UPR-RP 1982		X (Retired 2019)	Organic Chemistry	Organic Chemistry: organic synthesis, synthesis of biologically active compounds, Epoxide chemistry and organometallic synthesis.	31	CHEM-4025-Spectroscopy CHEM3031-CHEM3032-General Organic Chemistry CHEM-6411, CHEM-6412, Organic Chemistry Theory I & II CHEM-8405-CHEM 8406 Organic Chemistry Seminar I & II	3	
Pasquale Fulvio	Kent State University, 2009		Resigned 2018	Organic Chemistry	Self-assembly of building blocks into hierarchical porous frameworks, and biomimetic membranes. Nanomaterials with biocompatible surface groups. Energy storage, conversion, separations, and heterogeneous catalysis. Main techniques. Gas physisorption, TPD, thermal analysis, X-ray and neutron scattering, S/TEM, FTIR, Raman, NMR, cyclic voltammetry, impedance spectroscopy.	1	CHEM-8605-Chem 8606 Physical Chemistry seminar Chem-611, Advanced Physical Chemistry		x

Name of the Professor	Academic Preparation	Status		Specialty	Research areas	Years of service	Courses regularly offered	Quantity of supervised theses	International origin
		Collaborator	Member						
José A. Rivera	Massachusetts Institute of Technology, 2000		x	Organic Chemistry	Supramolecular chemistry, molecular recognition, organic synthesis, nanotechnology, bioorganic chemistry, medicinal chemistry.	18	CHEM3031-CHEM3032-General Organic Chemistry CHEM-6411, CHEM-6412, Organic Chemistry Theory I & II CHEM-8405-CHEM 8406 Organic Chemistry Seminar I & II CHEM-8901- CHEM 8902 Graduate Seminar I & II	1	
Arthur D. Tinoco	Yale University, 2007		x	Inorganic and Bioinorganic Chemistry	Bioinorganic Chemistry, Proteomics, Anticancer research, Metal-based	8	Q-6011, Q-6012, Inorganic Chemistry Theory I & II CHEM-8005 Inorganic Chemistry Seminar CHEM4000- Inorganic Chemistry CHEM-8901- CHEM 8902 Graduate Seminar I & II	3	x

Name of the Professor	Academic Preparation	Status		Specialty	Research areas	Years of service	Courses regularly offered	Quantity of supervised theses	International origin
		Collaborator	Member						
Osvaldo Rosario	UPR-RP, 1978		x	Analytical Chemistry	Development of Sampling and Analytical Methodology for Organic Pollutants.	40	CHEM4015-Instrumental Analysis CHEM-6215 Analytical Chemistry Theory II CHEM8205-CHEM8206 Analytical Chemistry Seminar		
Marvin Bayro	Massachusetts Institute of Technology. Cambridge. MA.		x	Physical Chemistry & Biochemistry	Biophysical Chemistry: protein structure and dynamics - Solid-state NMR Spectroscopy: methodology and applications - Structural Virology: understanding HIV particle formation - Biomaterials: protein stability and interactions with nanocomposites	4.5	CHEM 6611-CHEM 6612 Advance Physical Chemistry I & II CHEM4041-CHEM4042-Intermediate Physical Chemistry CHEM-8605-Chem 8606 Physical Chemistry seminar CHEM-8901- CHEM 8902 Graduate Seminar I & II		
Oreste Quesada	UPR-RP	x		Biochemistry	Biochemistry: How chemical nature of detergents affects the lipid composition of detergent-solubilized nAChR from *Torpedo californica* tissue.		CHEM-8801-CHEM8802 Biochemistry Seminar I & II	1	

B. Academic Load

Using the Academic Offer from for the 2019-2020 Academic Year, complete the following table:

Table 3.2. B. Academic Load Detail[15]

Professor	Rank	Regular Load								Other Tasks				
		Teaching		Research/ Thesis, Project, or Dissertation Director		Administration (Appointment)		Counseling		Courses	Ad honorem Tasks	Licenses	Other	Total, HS of "Other Tasks"
		HC	ETC	HC	ETC	HC	ETC	HC	ETC	HS	HS	HS	HS	
Bayro, Marvin	CX	3	0.25	9	0.75						2			2
Cabrera, Carlos	C	3	0.25	6	0.50						2		3	5
Carballeira, Néstor	C			6	0.50	6	0.50				3			3
Chen, Zhongfang	C	5	0.42	7	0.58									
Colón, Jorge	C	5	0.42	4	0.33	3	0.25				2			2
Diaz-Vázquez, Liz	C			6	0.5	6	0.50				5		3	8
Griebenow, Kai	C	6	0.50	6	0.5									
Guadalupe, Ana	C	3	0.25	3	0.25	6	0.50				2			2
López, Vilmali	CA	3	0.25	9	0.75						2			2
Montes, Ingrid	C	3	0.25	6	0.75					2	2		3	7
Nicolau, Eduardo	CA			12	1						2			2
Piñero, Dalice	CA	5	0.42	7	0.58						2			2
Quiñones, Edwin	C	9	0.75	3	0.25									
Rivera, José	C	8	0.66	4	0.33									
Rodríguez, Abimael	C	6	0.50	6	0.50									

LEGEND
I - Instructor
CA – Associate Professor
CX – Assistant Professor
C - Professor

HS – Weekly Hours
ETC – Equivalent of Full Load
HC- Crédit Hours

[15] The number of hours per week (HS) and the equivalency in complete task (ETC) will be established for the three main categories, teaching, research, and administration. The complete assignment equivalency (ETC) is calculated by dividing the number of credit hours dedicated to an assignment by the 12 credit hours per week that comprise the complete assignment (e.g., six credits dedicated to teaching equals 6/12, or 50% of the completed task).
Under the category "Other additional tasks", only the weekly hours dedicated to these tasks will be calculated; these will be added in the column of the total (Total HS of "Others").

1. How does the professor's profiles respond to the needs and aspirations of the Program in terms of specialization, internationalization, and development of research/creative work?

   The professors profile responds to the needs and aspirations of the Program since professor are recruited using the department recruitment plan that considers the needs and aspirations of the Program in terms of specialization, internationalization, and development of research work. Most of the professors of the department have research in transdisciplinary areas.

2. According to the categories in Table 3.2. B. describe the distribution of regular academic load. What are the average weekly hours spent on each job?

   During the past five years most of the professors devote 42% (5 crs) of their effort in teaching and 58% (7 crs) percent in research, except for the professor that oversee administrative duties. The last two years some of the professors have had to take additional teaching duties, since a considerable number of professors have retired, and the administration have not provided the resources to hire new professor.

3. Is the distribution of the academic load of the program professors adequate to promote their productivity and performance in teaching and research/creation?

   No, the last two years some of the professors have had to take additional teaching duties, since a considerable number of professors have retired, and the administration have not provided the resources to hire new professor. In addition, during the last two years the administration has required additional reports and information, that have increased the responsibilities of the professor limiting the amount of time that is available to creative work and research.

C. Research Projects and Creative Work

List the research projects and creative work carried out in the Program in the past five years (Add lines as necessary). If the Program has a Research Center, mark with an asterisk in the "Project Title" column those projects that belong to the Research Center. Put a (P) at the end of the project title for those projects that are planned.

1. Table 3.3.C.

PROJECT DIRECTOR	DEPARTMENT	TITLE	GRANTING AGENCY	BUDGET APPROVED/Total	PROJECT PERIOD
Tinoco, Arthur	Chemistry	Development of Peptide-Conjugate Biomimics for Targeted Ti(IV) Based Anticancer D*	National Institutes of Health	$1,392,000.00	1-Sept-2015 to Aug 31, 2016
Nicolau, Eduardo (Cruz-Tato, Perla Fellowship)	Chemistry	Fellowship: On the development of catalytic polymeric membranes for water purification and resource recovery from wastewater for life support systems	NASA-ASTAR	$165,000.00	1-Sept-2015 to Aug 31, 2016
Cabrera, Carlos	Chemistry	Development of a Biosensor Microchip for the Detection of Microorganisms and Cancer Cells a the Point of Care	Fideicomiso de Ciencia y Tecnología	$150,000.00	June 1, 2015 to May 30, 2016
Morales, Reginald	Chemistry	Support for University Biomedical Excellence at UPR-RP*	National Institutes of Health (RiSE)	$7,024,330.00	July 1, 2000 to June 30, 2019
López-Mejías, Vilmalí	Chemistry	Biocompatible-Tailored-Nanocrystal-Drug for Colorectal Cancer Treatment	Univ. of Puerto Rico, Central Adm. through RCSE-EPSCoR (IFN)	$200,000.00	May 5, 2015 to April 30, 2017
Piñero, Dalice	Chemistry	Multimodal Theranostic Nanoprobes for Non-Invasive Bioimaging and Photothermal Treatment of Cancer	Univ. of Puerto Rico, Central Adm. through RCSE-EPSCoR (IFN)	$200,000.00	May 5, 2015 to April 30, 2017

PROJECT DIRECTOR	DEPARTMENT	TITLE	GRANTING AGENCY	BUDGET APPROVED/Total	PROJECT PERIOD
Tinoco, Arthur; Piñero, Dalice	Chemistry Chemistry	REU Site: PR-CLIMB (Puerto Rico-Chemical Learning in Materials and Biomolecular Applications)	National Science Foundation	$202,082.00	Jun 1, 2016 to May 31, 2019
Cabrera, Carlos	Chemistry	I-Corps: Development of a Biosensor Microchip for the Detection of Cancer Cells at thePoint-of-Care	National Science Foundation	$50,000.00	Feb 15, 2016 to Jul 31, 2016
Nicolau, Eduardo	Chemistry	On the Design and Fabrication of Hybrid Multipurpose Materials Using Bionanomaterials as Separator for Supercapacitors	PR NASA Space Grant Consortium (RCSE-Central Administration)	$20,000.00	Mar 1, 2016 to May 31, 2017
Chen, Zhongfang	Chemistry	Theory-Guided Synthesis and Application Exploration of Arsenene and Antimonene	US Department of the Army	$49,993.00	Oct. 15, 2015 to July 14, 2016
Morales, Reginald	Chemistry	Support for University Biomedical Excellence at UPR-RP (RiSE)	National Institutes of Health	$7,024,330.00	June 1, 2014 to June 30, 2019
Tinoco, Arthur	Chemistry	Development of Peptide-Conjugate Biomimics for Targeted Ti(IV)-Based Anticancer D	National Institutes of Health	$1,392,000.00	Sept 1, 2016 to August 31, 2017
Piñero, Dalice; López, Vilmali	Chemistry Chemistry	MRI: Acquisition of a Single Crystal X-ray Diffraction Instrument for the Creation of an X-ray Diffraction Facility at the University of Puerto Rico.	National Science Foundation	$149,922.00	Aug 1, 2016 to Jul 31, 2019
Jessika Pazol (Graduate Student) Eduardo Nicolau	Chemistry Chemistry	Post-Hurricane Maria Aid for Researchers Grant Program (Mini Grant)	Puerto Rico, Technology and Research Trust	$1,000.00	
Perla E. Cruz Tato (Graduate Student) Eduardo Nicolau	Chemistry Chemistry	Post-Hurricane Maria Aid for Researchers Grant Program (Mini Grant)	Puerto Rico, Technology and Research Trust	$1,000.00	

PROJECT DIRECTOR	DEPARTMENT	TITLE	GRANTING AGENCY	BUDGET APPROVED/Total	PROJECT PERIOD
Tinoco, Arthur	Chemistry	REU Site: Puerto Rico Chemical Learning Integrated in Materials and Biomolecular applications (PR-CLIMB)	National Science Foundation	$297,183.00	May 15 to April 30, 2018

2. Discuss the degree of correspondence of the research carried out in the past five years and the research lines presented in table 3.1A.

   There is a complete alignment between the research carried out by the professors in the program and the research lines presented in Table 3.1A, but some professors have recently added new research lines.

3. If there have been changes in the research topics, are these the result of significant innovations in the areas of study of the Program, changes in the discipline, desirable practices, or foreseeable developments?

   Among the new research lines that have been added are nuclear energy, COVID-19 sensors, bone regeneration, all added due to significant innovation in research areas.

4. To what extent does the Program's research has an impact on student research (thesis and dissertation mentoring, supervision and training)?

   All research being conducted in the program is done by graduate and undergraduate students and impact their thesis and dissertation research work.

5. To what extent does the research of the Research Center(s) (if applicable) have an impact on the students' research (thesis and dissertation direction, supervision, and training)?

   Our research centers (CIREN, CIE2M, PR-SPRINT, Center for Advancement of Wearable Technologies CAWT) contribute significantly to the student research and the completion of their thesis and dissertation research work since students carry them out within those centers. These centers provide students with stipends, materials funds, access to instrumentation and technology, internship and networking opportunities with external collaborators, professional development, and technical workshops, among other educational and professional opportunities.

6. What activities does the Program carry out that have a direct impact on the profession or the community? (Participation in editorial boards, commissioned studies)

   A large majority of the professor in the program are members of several research centers. All our research centers (CIREN, CIE2M, PR-SPRINT, Center for Advancement of Wearable Technologies CAWT) offer student summer research camps, as well as the ACS Project Seed.

   In addition, during the academic year, several of these centers and the Student Chapter of the ACS visit communities and public schools and offer after-school programs, citizen science workshops and chemistry shows. In addition, we offer advice to students involved in Science Fairs and serve as judges in Science Fair competitions.

   One of our recently retired professors, Dr. Osvaldo Rosario, has been involved as environmental consultant of many community-based organizations and was honored by the AAAS-Caribbean Division for his contributions in these endeavors. Prof. Jorge Colón has been involved with the community of Vieques, Puerto Rico for many years and recently published a chapter that mentions some of those efforts in the book on the 25th Anniversary of the UNESCO Chair on Peace Education in our Río Piedras Campus.

7. What activities does the Research Center carry out (if applicable) that have a direct impact on the profession or the community? (Participation in editorial boards, commissioned studies)

All our research centers (CIREN, CIE2M, PR-SPRINT, Center for Advancement of Wearable Technologies CAWT) offer student summer research camps, as well as the ACS Project Seed experiences.

In addition, during the academic year, several of these centers and the Student Chapter of the ACS visit communities and public schools and offer after-school programs, citizen science workshops and chemistry shows.

8. Does the faculty currently collaborate in projects with peers on Campus, in other institutions in and outside of PR?

☒ Yes (Mention which) ☐ No

On Campus:

Department of Biology, Department of Environmental Science, College of Business Administration, College of General Studies.

Other institutions in Puerto Rico:

UPR-Medical Sciences Campus, UPR-Mayagüez Campus, UPR-Humacao Campus
Interamerican University
Ana G. Méndez University
Pontifical Catholic University of Puerto Rico

Other institutions outside of Puerto Rico (in the United States), for example:

Cornell University
Stanford University
University of Texas at El Paso
Brookhaven National Laboratory

Other institutions outside of Puerto Rico and the United States:
University of Nantes, France
Universidad de Alicante, Spain

D. Funds

Indicate the number of research and teaching assistants assigned to the Program, travel funds, and the number of trips made for dissemination of the research performed in the Program.

Table 3.4.D.

Year	Quantity of research assistants	Quantity of Teaching Assistants	Traveling Funds (Reserved in the Departmental budget)	Quantity of trips used for dissemination of research
2015-16	0	36	$5,000	
2016-17	0	29	$5,000	
2017-18	0	41	$5,000	
2018-19	0	38	$5,000	

2019-20	3	15	$5,000	

1. What incentives provided by the Program, the College or School and the Campus do professors and students use for research / creation?

   Other than the FIPI program, a competitive in-house small research grant program, there are no other incentives provided by the Program, the College or School and the Campus used by professors and students for research / creation.

2. ¿ Do you consider that the amount and type of incentives that the Program offers to professors is sufficient to encourage research / creation in your Program?

   ☐ Yes ☒ No (Explain)

   Since there are virtually non-existent, they are not sufficient.

3. Do you consider that the number of teaching or research assistantships are sufficient to satisfy the needs of the Program and of the students as a training experience?

   ☐ Yes ☒ No (Explain)

   The number of teaching assistantships and research assistantships is not sufficient to satisfy the needs of the Program. In addition, the salary that students receive in the campus assistantships is way too low. Many students must take jobs outside campus, limiting their time to focus on their research.

4. Is the institutional support provided through assistantships, travel funds, etc. adequate for the development of research and creative work in the Program?

   ☐ Yes ☒ No (Explain)

   The budget granted to the department is limited and barely enough to cover the costs of the expenses of the courses of the academic offer at the undergraduate level. From the budget assigned to the Department, during the last five years, $ 5,000 dollars have been set aside for the graduate program and associated research trips.

5. What steps does the Program take to raise more external funds for its research?

   Professors in the graduate program are active in writing successful proposals and establishing alliances and collaborations.

6. Are the professors and academic management of the Program able to raise sufficient external funds to finance the research?

   ☐ Yes ☒ No (Explain)

   Professors do raise sufficient funds to finance their research, but the academic management of the Program has not raised sufficient funds to finance research in the Program.

E. Student Research

List the amount of research carried out and disclosed by students, including Theses, Dissertations

and Degree Projects, either in conferences, congresses, seminars or in publications (It can also be included as an appendix with the same information requested).

Table 3.5.E. in Appendix 5 shows a list of the research carried out and presented by students in the program.

1. What does the data in Table 3.5.E reflect on student research throughout these years?

   The data reflects that the student research has been maintained at a high level throughout the years.

2. What initiative should the Program take to increase the dissemination of student research?

   Identify new sources of funds to allow us to (partially) cover travel expenses for student making presentations in local, national, and international conferences.

   A newsletter of the Department of Chemistry would allow us to disseminate opportunities for students willing to disseminate their research.

3. What percentage of undergraduate students participate in the research carried out by the Program? 35%

   In terms of the average number of undergraduate students in the last two years, 35% of the students majoring in Chemistry are enrolled in the QUIM4999 undergraduate research chemistry course which is carried out by professors in the program.

4. What initiatives can the Program develop to increase the participation of undergraduate students in research projects?

   Carry out more Open Houses, research seminars aimed at undergraduate students, and visit courses in other institutions to talk directly to Chemistry students.

F. Publications

In the following table indicate the publications developed by the professors of the Program in the last five years. Indicate the title or bibliographic record of the same. In the last column, mark with an (X) those that have been published in peer-reviewed journals (It can also be included as an appendix with the same information requested).

Table 3.6.F. Appendix 6 shows the publications of our faculty in the past five years.

1. What is the expectation of the Program in terms of the number of publications that it expects annually from each professor?

   To maintain the productivity level of at least 3 publications per year per professor.

2. What trend was observed in the production of research and creative work captured in peer-reviewed publications? What trend was observed in the production captured and disseminated through other means with recognition in the discipline?

   That even with the hurricanes, earthquakes and pandemia, the production of research and creative work has maintained the high levels of productivity

3. Does the Program have its own publication?

☐ Yes (Answer questions 4 and 5)
☒ No (Go to question 6)

Title	Year it started

Type of Publication	
	Printed
	Electronic
	Every six months
	Annual
	Other:

Circulation	
Quantity Released:	

Distribution	
	Federal Post Office
	Internal Post Office
	By exchange
	Other:

4. Does the present Editorial Board of the publication of the Program (if applicable) include international members? What is the proportion of international members in relation to the total?

N/A

5. Does the publication have sufficient scope to make the research generated known among the important populations of the Program (students, researchers, prominent forums)?

N/A

6. What strategies for disseminating your research does the Program use inside and outside the Campus? Describe them.

☒ Publications (journals, books)
☒ Forums

☒ Congress

☒ Seminars for the university community

☒ Seminars for the external community

☐ Other _____

7. According to the data collected in this section, is the number of publications in the past five years, in accordance with the goals and objectives set by the Program, reaching the expectations - level of achievement - of annual publications that were held per professor? Explain the reasons that have supported or limited the development of publications by professors.

   Yes. Professors in the program are highly motivated to continue their research progress and have exceeded expectations in terms of research publications and presentations.

8. What has been the impact of the publications on the competitiveness and projection of the Program?

   The competitiveness and projection of the Program has been increasing steadily thanks to the impact of the publications and presentations of our faculty and students.

IV. Students/Alumni

This section examines the scopes of recruitment, admission, and retention policies and practices, enrollment trends and projections, among other indicators of the program's success in achieving its mission, goals, and objectives.

A. Threshold of the program

1. Indicate the program threshold: ___30 (admitted each year)_____

2. Mark which of the following criteria are considered to determine the threshold of the program:

   ☒ Schedule of courses: daytime, evening, Saturday, or others

   ☐ Course offerings: face-to-face, hybrid, distance and online.

   ☐ Diversity of the student population.

   ☒ Number of active students

   ☒ Budget

   ☒ Quantity of courses to be taught

   ☒ Quantity of professors available to teach courses

   ☒ Number of active researchers to supervise theses, dissertations, and degree projects

   ☐ Number of students in extension

   ☐ Assistantships available

☒ Facilities

□ Other: _____

B. Recruitment

1. What were the strategies that were used to attract and recruit students? Which ones have been shown to be most effective? Explain

   ☒ Graduate studies fair

   ☒ Promotions on the virtual pages of the institution and the Program

   ☒ Promotions on social media

   □ Advertising campaign

   ☒ Visits to universities or Campuses

   □ Others_____

2. How effective has the Program been in attracting and recruiting a diverse and qualified student population?

   Not enough. We are successful in attracting and recruiting a diverse and qualified student population, but if our stipends for students were higher, approaching what is offered in other comparable programs in the US, we could attract and recruit many more.

C. Student Population

Provide the student population distribution figures for the past five years in the following table.

Table 4.1.A.

Year	Threshold	Applicants		Admitted		Selectivity %		Admitted from UPR System		Enrolled		Enrolled Status	
		Male	Female	Male	Female	Male	Female	Río Piedras	Other UPR system	Male	Female	Part time	Full time
2015-2016	30	15	15	13	11	54	46	4	7	9	7	0	16
2016-2017	30	19	15	13	12	52	48	12	5	6	7	0	13
2017-2018	30	12	9	10	8	56	44	12	3	8	6	0	14
2018-2019	30	9	14	8	10	44	56	2	1	5	9	0	14
2019-2020	30	13	14	12	14	46	54	2	4	10	11	0	21

1. Consider the data provided in the table above and evaluate. How selective[16] and attractive[17] is the Program?

   The percentage of selectivity of the program on average is 50% for male students and 50% on average for female students. The average attraction percent is 68% for male students and 73% for female students, which we consider satisfactory.

2. What is the sociodemographic and academic profile of the students applying for new admission, admitted, and enrolled in the Program and how is it related to academic success?
   ● Describe the distribution of enrollment in terms of gender.

   During the years included in this self-study, the distribution was equitable between the enrollment of male and female students.

   ● Describe the distribution of full-time and part-time students.

   All students in the program are full-time students.

   ● Describe the proportion of students admitted from the UPR-Río Piedras Campus with that of those admitted from other units of the UPR System.

   For two of the five years included in this self-study, the majority of students admitted came for the UPR-Río Piedras campus. The other years, the majority were from other UPR units.

   ● Describe and compare the number of students per UPR campus that come from other countries

   All students admitted to our Program from other UPR units are local; none come from other countries.

3. What shows the trend in the demand for new admission and admitted to the Program during the last five years?

   The demand and the number of students admitted to the program has diminished during the last 5 years. It must be taken into consideration the external factors that have affected student recruitment in the period covered by this Self-Study, such as a student strike in the second semester of the 2016-2017 academic year, and the hurricanes Irma and María in the first semester of the 2017-2018 academic year. In addition, the economic crisis on the island has increased migration to the United States, diminishing the pool of students targeted for recruitment. Finally, immigration policies during the Trump administration were detrimental for the influx of new international students.

4. How do applicants and admitted trends compare with the quota established for the Program?

   On average, the number of applicants and admissions has been below the threshold.

[16] Selectivity refers to the number of students admitted from applicants.

[17] Attractiveness refers to the number of accepted students who eventually enroll.

5. How have admissions adjusted relative to quota over the past five years? Explain the reasons for making these changes.

   There has been no need to adjust admissions due to the threshold since we have never surpassed it.

6. How does the number of students enrolled annually in the program compare to the projected enrollment?

   The number of new students enrolled is less than the one projected.

D. International Students

Indicate in the following table the number of international students who have applied for admission to the Program, those who have been admitted and enrolled.

Table 4.2.A.

Year	International		Admitted	Enrolled
	Quantity	Country of origin		
2015-2016	11	China, Colombia, India, EE.UU., Dominican Republic	8	6
2016-2017	9	India, Colombia, Chile y China	5	2
2017-2018	2	Chile, South Africa	2	2
2018-2019	6	Colombia, Dominican Republic, Perú	5	3
2019-2020	3	China, Colombia, Perú	2	2

1. How diverse, in terms of specific backgrounds, is the student body of the Program?

   It is very diverse, including students from Latin America, the Caribbean, Asia, and Africa.

2. Describe how diversity contributes to the competitiveness, enrichment of the Program and the goal of internationalization of the Campus and the UPR.

   Learning from other cultures takes place spontaneously when the integration of students with different cultural backgrounds is achieved, which has been one of the successes of the program. Bringing students from other cultures who have commitments, lifestyles, study methods and teaching approaches different from ours increases the competitiveness of the program since students contribute to their courses both in the construction of ideas and in the formulation and the analysis of scientific questions in various ways. Therefore, the program's students have the opportunity to enrich their analytical skills, increase their vision of what other programs in other countries provide, and become familiar with the reality of social problems facing other regions of the world.

   The commitment of the chemistry graduate program to provide degrees of higher education to our neighboring countries in the Caribbean led to the establishment of a MOU with the State University of Haiti (UEH) and UPR Rio Piedras Campus. The first Haitian graduate student graduated from the program in 2020, and two (2) more should graduate between now and 2022.

One of our faculty members, Dr. Zhongfang Chen, who is originally from China, has been successful recruiting students from China to our program; over eight (8) students have joined our program since the last self-study.

The program also has students from Chile, Colombia, Venezuela, Peru, among other countries.

E. Student Retention

Indicate the number of students per cohort for each academic year. According to the criteria established in Certification 95,[18] calculate the retention rate for the second and third year, if the evaluated program is a Master's, and for the second and fourth year if it is a Doctorate. Then set the retention[19] percentage for those years.

Table 4.3.B.i M.S. Program

Year of admission	Amount of admitted students	Amount of students enrolled second year		Amount of students enrolled Third year		Amount of students enrolled fourth year	
		#	%	#	%	#	%
2015-2016	0	-	-	-	-	-	-
2016-2017	3	2	66	1	33	1	33
2017-2018	0	-	-	-	-	-	-
2018-2019	4	3	75	3	75	N/A	
2019-2020	2	2	100	N/A		N/A	

Table 4.3.B.ii Ph.D. Program

Year of admission	Amount of enrolled students	Amount of students enrolled second year		Amount of students enrolled Third year		Amount of students enrolled fourth year	
		#	%	#	%	#	%
2015-2016	16	14	88	13	81	13	81
2016-2017	10	8	80	8	80	8	80
2017-2018	13	13	100	13	100	13	100
2018-2019	10	8	80	7	70	N/A	
2019-2020	16	12	75	N/A		N/A	

1. Mark with an (X) the main reasons why students did not complete their Program. Use information that has been collected by the Program itself through questionnaires or other documents.

    □ Physical disability

    □ Service in the Armed Forces

[18] Certification 95, 2019-2020, Academic Policy of Graduate Studeies in the Río Piedras Campus of the University of Puerto Rico.

[19] Number of students enrolled each year divided by the number of students enrolled in the first year of study.

□ Prolonged absence

□ Academic suspension (GPA)

☒ Voluntary withdrawal*

□ Lack of financial resources

☒ Health difficulties

□ Limitation of student services

□ Lack of resources in the Program

☒ Interpersonal relations with the Faculty

□ Limitations in the academic offer

□ Little diversity in the offering

□ Inconvenient schedule

☒ Other reasons: ___Mismatch in the expectations of the mentor-student research work plan_____

2. What information emerges from the analysis of the data included in tables 4.3.B and from the criteria in question 1?

   From the information gathered it has been noticed that the pandemic situation that forced all education, at all levels, to move to online education, put time restraints to students who are heads of their family, as they must help their children manage online learning.

3. What actions has the Program carried out to assist students when they wish to withdraw? Which ones should it take?

   When the coordinator learns about a student who is considering withdrawing from the program, options are presented to the students, meetings are held to better understand the situations that the student is having and discuss ways to help them.

   The program has approved this semester to assign two professors as academic advisors. We envision that if a situation of this kind occurs again, that these professors can further assist these students.

F. Economic Incentives

In the table below, record the number of students who have applied for loans, assistantships, or scholarships in the past five years. In each column, record the data corresponding to the number of incentive requests and those that were granted.

Table 4.4.C.

Year	Loans		Assistantships[20]		Scholarships	
	Requested	Granted	Requested	Granted	Requested	Granted
2015-2016						

[20] Recurring institutional funds from the faculties, schools and DEGI (FIPI, PEAFs) granted in order to provide economic incentives to graduate students to dedicate full time to their studies and to promote the development of research and creative activity in the field. Enclosure. These include assistantships for teaching experiences, research or creative work experiences, and professional experiences.

2016-2017						
2017-2018						
2018-2019						
2019-2020						

1. Compare the demand for financial aid by the students of the Program with the granting of the different incentives.

   The demand is much higher.

2. What actions has the Program carried out to meet the demand for financial aid from the Program's students?

   The Program has consistently voiced their concerns with the administration that the stipends for graduate students must be increased, or otherwise we will not be able to recruit and maintain students.

G. Graduation

1. Time to complete the Degree

a. In compliance with the academic policy for graduate studies of the Río Piedras Campus (Certification 95), is it evidenced in the study program the time it will take for the student to complete the degree and the order in which they must take the courses and other curricular experiences (if applicable) to finish in the stipulated time? Explain the answer.

   ☒ Yes ☐ No

   The Regulations of the Chemistry Graduate Program specify a suggested curricular sequence which if followed a student would complete the Ph.D. program in 5 or 6 years

b. Does the Program have an orientation program on the importance of following the curricular sequence and the implications of not following it?

   The Program conducts an annual orientation with first year graduate students in which the importance of following the curricular sequence is emphasized.

c. What is the average time, in terms of years, that students take to complete the degree of your Program[21]? 7-8 Years

d. Do students face any problem to complete the degree in the time stipulated in the study program?

   Yes. Due to financial constraints, many must take outside jobs, procurement of materials and supplies take too much time, as do equipment repairs, and the many degree requirements is also a big factor.

[21] You can request this information at the Institutional Research and Appraisal Division, attached to the DAA

2. Graduation rate [22]

Using the number of enrolled students as a reference (See Table 4.3 B), indicate in the following tables the number of students graduating per year from the MA and Ph.D. Program. Write the data in the column that corresponds to the Program.

Table 4.5.D. MASTERS

Year of admission	# of students admitted	# of students that graduated in 2 years	# of students that graduated in 3 years	# of students that graduated in 4 or more years
2015-2016	0	1	0	0
2016-2017	3	0	0	2
2017-2018	0	1	0	0
2018-2019	4	0	0	0
2019-2020	2	0	0	0

Table 4.5.E DOCTORATE

Year of admission	# of students admitted	# of students that graduated in 3 years	# of students that graduated in 4 years	# of students that graduated in 5 years	# of students that graduated in 6 years	# of students that graduated in 7 years or more
2015-2016	16	1	0	0	1	2
2016-2017	10	0	1	0	1	4
2017-2018	13	0	0	4	0	2
2018-2019	4	0	1	1	2	5
2019-2020	12	1	3	1	1	4

a. How does the quantity of degrees conferred compares with the projected quantity of degrees?

   The degrees conferred somewhat compares favorably with the projected quantity of degrees.

b. What was the graduation rate of the students admitted in the program and what strategies were implemented to improve it in case it was not the expected one?

   The graduation rate of around 7 degrees per year is close to the expected one. The revision of the M.S. and Ph.D. program should reduce the time-to-degree and increase this number.

H. Alumni

1. Describe the process or system that the Program uses to monitor its alumni.

   We contact the alumni every five years or so as part of the Self-Study evaluation of the program. We have a list of all alumni from the program which we try to keep updated.

2. What strategies did you use to collect the data from the alumni?

[22] You can request this information at the Institutional Research and Appraisal Division, attached to the DAA

We send a survey to alumni every five years or so as part of the Self-Study evaluation of the program.

3. What data did you collect to demonstrate the success of the alumni?

   The alumni survey data (see Appendix 3).

4. How does the Program maintain contact with its alumni?

   Through e-mail and social media.

5. Where are alumni of the Program employed and how long does it take them to obtain employment after graduation?

   The alumni of the program are employed in academia, industry, and government. Some examples are Eli Lilly Pharma, Boston College, Brooklyn College, Louisiana State University and University of Puerto Rico, and University of Bristol (England). Alumni can obtain employment within six months of graduation.

6. What is the percentage of alumni who continue more advanced studies annually? What strategies does the Program use to support alumni towards these ends?

   40% of alumni continue more advanced studies. Professors in the program motivate, advice and help students to pursue more advanced studies. In addition, research experiences undertaken by our students at other universities or research institutions provide role modeling examples that build postdoctoral positions aspirations.

7. How have the data and information on the alumni been used to strengthen the program? Describe the actions implemented and the results achieved.

   The data and information of the alumni has been used to design the revision of the Chemistry Graduate Program, both at the M.S. and Ph.D. level. The proposal for that revision has already been approved at the Department, College, and Deanship of Graduate Studies and Research levels and is currently under review by the Academic Senate.

V. Essential Resources and Services for Teaching, Research and Creation

This section examines the efforts of the Program to provide quality resources and services to support professors and support staff, essential for learning, research, and creation.

A. Services and Support Personnel

1. What data shows that the capacities and number of available staff and support services respond to the demand and identified needs of students?

   The current capabilities and number of available support staff is not enough to respond to the demand and identified needs of students in the program, as evidenced by a survey about these services conducted among professors, students, and staff. The Chemistry Graduate Program doesn't have any assigned full-time administrative assistant.

2. What does the data from the past five years show about levels of efficiency, effectiveness, and satisfaction with support services?

   According to the survey administered to students and professors 71% were satisfied or highly satisfied with the support services offered by the administrative personnel of the department from 2015 to June 2020. However due to the retirement of the program administrative assistant, Mrs. Wilma Santiago in June 2020 some of the support services offered have been affected and delayed as expressed before.

3. What changes or revisions did you make in the services offered by the Program?

   Ever since our full-time assigned administrative assistant was moved to the Office of Graduate Studies and Research, we lost this support. The past administrative assistant retired in June 2020, leaving us with no direct support for our professors and students. The currently assigned administrative assistant is also in charge of several graduate programs.

4. How did the Program ensure that students had access to adequate and quality academic and career advising services?

   The mentor and the Thesis Committees offer academic and career advising services to each student. In February 2021, two professors in the program were selected as Academic Advisors to the students in the program.

5. How does the Program implement academic and professional counseling services?

   The mentor and the Thesis Committees offer academic and career advising services to each student. In February 2021, two professors in the program were selected as Academic Advisors to the students in the program. A general announcement was made to the students about the availability of these services.

6. How does the Program inform its students about the requirements, regulations and institutional services of the Campus and the Program? (Include examples of these in the annexes section)

The Program sends each incoming graduate student the Bylaws (Appendix 9) that include the requirements and regulations of the program. The Deanship of Graduate Studies and Research informs the graduate students about institutional services.

7. What regulations and procedures does the Program use to address student situations or complaints? What have been the most common causes of these complaints?

   The Chemistry Graduate Program has a Graduate Affairs Committee and an Academic Affairs Committee. The Department has a Discipline Committee and a Safety Committee. According to the nature of the complaints that are presented, they are assigned to the corresponding committee. Among them are discrepancies in the way a course is evaluated, extensions to probation status, and situations related to the conditions of the laboratory facilities.

8. On what information was the program based to implement the improvement for support staff and what impact the activities had offered in the quality of services?

   We have informed the Dean about the demand and identified needs of students that need to be answered by the administrative assistant and support staff. We have asked for a full-time administrative assistant for our Program. We have been informed that there is no budget available for this position.

9. What were the professional improvement activities that were organized to program support staff for the past 5 years?

   During the past five years the program support staff have participated in ethics seminars and workshops, the assessment coordinator participated in the OLAS system workshop. More recently during the pandemic all staff were required to complete the COVID-19 course offered by the DECEP.

B. Learning Resources and Information

This section examines the learning and information resources (bibliographic and informatics) available and accessible to faculty and students.

Indicate the amount invested in the purchase of bibliographic resources, the type of resource and the number of recommendations for the purchase of bibliographic resources issued by the teaching staff.

The major investment in bibliographic and informatics resources in the past few years have been related to the access to SciFinder and the online journals, both of the American Chemical Society. The SciFinder subscription has a cost of $35,000 per academic year. In addition some specialized software libraries such Cambridge Crystallography database, has been acquired annually for a cost of $3,600.

Table 5.1.A.

Year	Quantity invested in bibliographic resources	Type of acquired resource (books, databases, film material,, peer-reviewed journals, etc.)	Number of recommendations for the purchase of bibliographic resources issued by the faculty
2015-2016		Science Finder	
2016-2017		Science Finder Cambridge CCDC*	
2017-2018		Science Finder Cambridge CCDC*	
2018-2019	$35,000	Science Finder Cambridge CCDC*	2
2019-2020	$37,000	Science Finder, Cambridge CCDC*	2

* The Cambridge CCDC license was purchase through one of the major sources of funding from one of the grants approved for one of the professors in the program: the CIRE^{2}N program.

Make a list of the courses offered by the Program in which technology is used for more than just word processing, for example: statistics management, simulations, data management, translation or languages, distance education, technology for learning, online courses, Internet page design, Moodle, among others.

Table 5.2.B.

Course Code	Course Title	Type of technological resource
CHEM 6011	Theory of Inorganic Chemistry I	Moodle, Google Meet, Zoom
CHEM 6012	Theory of Inorganic Chemistry II	Moodle, Next, Google Drive and a Weebly page, Google Meet, Zoom
CHEM 6215	Theory of Analytical Chemistry	Moodle, Google Meet, Zoom
CHEM 6225	Theory of Instrumental Analysis	Moodle, Google Meet, Zoom
CHEM 6411	Theory of Organic Chemistry I	Moodle, Google Meet, Zoom
CHEM 6412	Theory of Organic Chemistry II	Moodle, PPT slides, Internet pdf scanning and file transfers, problem reference solutions and evaluation, Google Meet, Zoom
CHEM 6611	Advanced Physical Chemistry I	Moodle, Google Meet, Zoom
CHEM 6612	Advanced Physical Chemistry II	Website, e-mail Communications, Google Meet, Zoom
CHEM 6811	Advanced Biochemistry I	Moodle, Google Meet, Zoom
CHEM 6812	Advanced Biochemistry II	Moodle, Google Meet, Zoom
CHEM 6905	Principles and Practices of Chemistry I	Moodle, Google Meet, Zoom
CHEM 6906	Principles and Practices of Chemistry II	Moodle, Google Meet, Zoom
CHEM 8990	Special Topics in Inorganic Chemistry	Moodle, Google Meet, Zoom
CHEM 8992	Special Topics in Analytical Chemistry	Moodle, Google Meet, Zoom
CHEM 8994	Special Topics in Organic Chemistry	Moodle, Google Meet, Zoom
CHEM 8996	Special Topics in Physical Chemistry	Website, e-mail Communications, Google Meet, Zoom

1. What bibliographic resources does the Program currently have? (This information should be obtained from your Librarian.)

☒ Books (Number of the Titles:)

☒ Database (Mention: SciFinder, Cambridge Structural Database, Chemical Abstracts)

☒ Journals (Amount of Titles:)

☒ Electronic Journals (Mention: All journals in the following publishers are available in electronic form: ACS, Wiley, RSC, Elsevier)

☒ Computer Programs (Mention: Web EndNote)

☒ Number of licenses: 3 (SciFinder, Web EndNote, Cambridge Structural Database

□ Others: _____

2. Does the Program have access to adequate and sufficient journals and resources to develop and sustain the research?

   No. Recent budget cuts have limited our capabilities in terms of access to non-ACS research journals and published data. As more journals enter into the Open Access format, some of these difficulties might be reduced.

3. Does the Program have research / creation projects (and its Research Center, if applicable) or teaching, that require exclusive technology dedicated to them? Explain.

   Professors who do computational chemistry, such as Professor Zhonfang Chen, and crystallography, such as Professor Dalice Piñero, make use of computers and programming exclusively dedicated to these research projects. There are computers and programs exclusively for scientific instrumentation, some for shared use.

4. What evidence shows that the faculty and students accessed and used the information in various formats, including electronic sources of information? Are they easy to obtain in their full version? Are the resources orderly and in good condition?

   The ACS Sci-Finder license allows faculty and students to access and obtain full versions of publications in all ACS journals. In addition, the evidence is in the publications that are required in some courses, where students make use of the available electronic sources of research publications in journals to complete the course requirement of publishing a peer-reviewed manuscript.

5. What evidence shows that the available information and learning resources were effective in achieving the mission and goals of the program? What, if anything, do you suggest modifying?

   The student survey and the presentations and papers published by students demonstrate the available information and learning resources were effective in achieving the mission and goals of the Program.

6. How does the program show its progress and achievements in the use and integration of technology?

- Capacity of the faculty in the use of technology
- Integration of information skills into the curriculum, including computer skills and computer literacy
- Assessment of the effectiveness of the learning experience and the program
- Technological support to the institution
- Strengthening of the research
- Strengthening of the services

The COVID-19 pandemic forced all courses to be online and faculty and student had to adapt to improve computes skills and computer literacy skills to complete courses and continue research. Today's research requires many technological and computational skills all the way from Microsoft Word to Gaussian 16.

7. What changes or revisions were made to ensure the effectiveness of the integration of learning and information resources in the academic and administrative components of the program?

   The recent revision of the M.S. and Ph.D. programs and its assessment of student learning which are now done every semester will help the program better access the effectiveness of the integration of learning and information resources.

C. Technology Plan

1. Describe the characteristics of the Program Technology Plan, existing or under development.

The program currently does not have a Core Technology Plan. However, the research labs are totally proficient and up to date in the required technology to further their research interests.

Criteria	YES	NO
Does the plan include the acquisition, updating, maintenance, distribution, and replacement of technology?		
Does the plan include training for teaching and non-teaching staff?		
Does the plan include training for students?		
Does the Program have a budget for the implementation, development, and maintenance of the Technology Plan?		
Does the Plan consider an item within its budget for maintenance and updates (upgrading) for technological resources, for example: operating systems, Computer programs, memory, among others?		
Does the plan consider expanding resources, services, and hours?		

2. Evaluate how adequate the technological resources of the Program are to promote productivity and excellence in the teaching of its professors.

a. Is the student to computer ratio adequate?[23] Explain

Most of the students enrolled in the Program own a laptop or a tablet and do their work and access the Internet through them. The Program does not have computers other than those owned by the Program Administrative Assistant. However, the research laboratories have adequate laptop and desktop computers resources to fulfill the students and lab personnel needs.

The administrative assistant assigned to the Program is assigned a desktop computer. If we use that number to calculate the ratio of students per computer, it would give a number of 79 for the 2019-2020 Academic Year. But the reality is that students, if they do not have a laptop, use the computers that professors of the program have in their laboratories.

The Faculty of Natural Sciences through its Library makes available laptops computers to graduate students, including the ones in our program.

b. Are the available computer programs sufficient and adequate for user demand? Explain

More computer programs suitable for user demand are needed if each one was to be used individually. However, the campus-wide access to the MS Office 365 application through the University portal makes it possible to use these applications for free, thus providing access to all students.

c. Are the functions of these facilities of the personnel, of the services offered, in accordance with the needs of the users and expectations for the development of the Program?

The facilities used by students and professors, apart from what each professor has in his/her research laboratory, consist mainly of what "Center for Information and Technology (CITEC for its acronym in Spanish) provides in the Néstor Rodríguez Rivera Library in the College of Natural Sciences. These facilities are consistent with the needs of users in terms of offering workshops on using MS Office programming, on creating bibliographic files, on the use of EndNote Web and on scholarly communication, among others. CITEC has the list of trainings available at http://www.bcn.uprrp.edu/literacy/courses_spanish.html.

d. How adequate are the facilities, bibliographic resources and technological equipment for the needs of the users and the development expectations of the Program?

The use of technology is limited by the lack of constant access to the Internet. Access to Ethernet cables is very limited in the Facundo Bueso Building, where most of the Program's professors, students, and laboratories offices are located. On the other hand, the Wi-Fi signal on Campus, although improved for the condition five year ago, sometimes is sporadic and inconsistent. It is necessary to improve this access to the Internet in the building to take full advantage of this tool.

e. What does the Program need to do to update bibliographic resources, improve

[23] The student to computer ratio refers to the number of enrolled students divided by the number of computers the Program has.

physical infrastructure, acquire, and maintain adequate technological resources?

Get more funding allocations to update and maintain all these resources.

D. Facilities, Laboratories and Auxiliary Equipment for Teaching

1. Did the Program have the facilities, laboratories, equipment, instruments, and other auxiliary resources projected five years ago?

   Five years ago, we mentioned in the Self-Study that the program has adequate number of laboratories, equipment, instruments, and auxiliary resources for teaching, but that it only has available under its control one teaching classroom. The situation remains the same.

2. Have the facilities, laboratories and auxiliary equipment been updated to meet the advances in the program and in the discipline?

   Through the research grants that have been approved for the establishment of research centers we have been able to update facilities, laboratories, and auxiliary equipment to meet the advances in the program and in the discipline.

3. What do the findings of the physical facilities appraisal conducted over the past five years demonstrate?

   The facilities in the Facundo Bueso building suffer from being in an old building that makes somewhat difficult to maintain an optimal environment. In addition, the budget cuts have prolonged the time needed to make renovations to the facilities.

VI. Management, Planning, and Development

This section examines the operation, as well as the impact of the policies, procedures and management and administrative practices in the successful performance of the Program. The program's efforts to engage effectively with its constituents and surrounding communities are examined. In addition, the relationship between the budget and the mission, goals and objectives of the program is exposed.

G. Operation of the Program

1. Management

To complete this section, two surveys were sent to all professors, students, and alumni of the program. A total of 20 people answer the survey, of which 65% were current graduate students, 15% professors, 15% alumni and 5% students with a study permit.

a. Is the management of the Program perceived as an agent of change?

Of the total of those surveyed, 60% perceived the management of the Program as an agent of change.

b. What are the biggest administrative challenges that the Program faces today? What steps should you take to deal with them?

The biggest challenges are the lack of trained personnel to support faculty and students, and the lack of budget to cover program expenses.

The Department has requested to hire an administrative assistant to cover the position left open when Mrs. Wilma Santiago retired, as well as the one left open when Aida Arce retired. None of those two positions have been filled.

In addition, important decisions on physical facilities, materials and supplies are taken at higher administrative levels, limiting our ability to solve problems related to these issues.

The program created a Committee for the Assessment of Student Learning. Its coordinator, Dr. Dalice Piñero, she is currently the Student Learning Assessment Coordinator for the program. Meetings with students in the program have been performed to ask them about their needs.

Student counseling needs improvement. The program lacks tools to prepare students in the workforce outside of technical literacy (i.e., management, inventory, budgeting, teamwork, etc.).

In a recent survey to students and professors on management, 24 of 58 (41%) responses are satisfied (Excellent, Good) with the academic management. 71% said that the management of the Chemistry Graduate Program is good or excellent.

c. Does the Program management provide its students, graduates, professors, and staff with an excellent service in all its areas? Are there any service areas that require special attention? What adjustments or additional investment would be required to raise the quality of the Program?

The Program aims to provide an excellent service in all areas to students, alumni, and professors, however, currently we have not been able to do that in a satisfactory way. As stated before, 41% of responders to the Self-Study survey are satisfied with the academic management of the program. Much improvement is needed, as evidenced by these responses.

Based on the responses to the Self-Study survey, there are several service areas that requires special attention. Among them are: 1. Improved student counseling on the program requirements and interpretation of the program regulations (bylaws); 2. Better and more constant communication with students in all aspects of the program, including requirements and administrative processes; 3. Administrative procedure and paperwork related to TA contracts and their approval.

The improve the quality of the program in terms of the academic management we need to have better administrative support, particularly with at least a full-time administrative assistant assigned to the program. We used to have such a position assigned to the program, but due to fiscal constraints, that person was assigned to work with several other graduate programs, reducing the services and the assistance to our students, alumni, and professors. Among those are delays in important processes such as enrollment and contract preparation for students' stipends, which are among the main complaints of the students.

In addition, a formal process of counseling between students and the Coordinator must be implemented, where the student presents his/her Individualized Development Plan (prepared with their graduate research mentor) and fills a draft of the Academic Status Sheet that is given to the new graduate student upon entering the program as part of the program regulations document. The Academic Status Sheet allows the student to understand how many requirements he/her has completed and how many remain.

Finally, there are budget constraints that do not allow us to offer the students a student meeting area with the minimal facilities (tables, computers, printers, seating area, board, coffee area, etc.).

d. Do you think that the support received from senior university management has been adequate to meet the needs and aspirations of the Program?

No. In numerous occasions we have communicated with upper administration officials to obtain support for initiatives to better meet the needs and aspirations of the Program, only to be ignored. We have not felt support from the upper administration to our efforts to help in the development of our program.

e. What policies or procedures (if any) related to university senior management do you think should be modified to facilitate the operation and development of the Program? What recommendations can you outline?

1. To allow the graduate programs more autonomy to be able to manage all student TA/RA contracts in our Department.
2. More control of the Department of Chemistry budget
3. Faster administrative procedures such as purchasing and infrastructure repairs.
4. Attention to the following OSHA regulations (occupational laboratory safety, fume hoods, pest control, water leakages, black molds, air conditioners maintenance and repairs, electrical system maintenance and repairs).

2. Administrative Personnel

a. What is the profile of the program's administrative and support staff and how did it contribute to its effectiveness?

In the past, our program had a full-time administrative assistant. Later, this person was moved to the Office of Graduate Studies at the Deanship of the College of Natural Sciences and she must assist other graduate programs. The administrative assistant that we had for the last 20 years retired in summer of 2020. Currently, we don't have a full-time administrative assistant assigned to our program. The Deanship of the College of Natural Science has been assigned an administrative assistant to our program; however, this person also assists almost all other graduate programs in our College. We need having again a full-time administrative assistant, since we have been experiencing much trouble managing all services to students (enrollment, TA contracts, monitoring of students' graduation requirements, etc.).

b. How does the profile of administrative and support staff respond to administrative policies, procedures, and practices?

The previous administrative assistant had the highest job classification. To better fulfill the policies, procedures, and administrative practices of our program, we need to have again a full-time administrative assistant.

c. How adequate is the coordination of the operation of the program between the managerial and administrative levels?

We have the full support of the Office of the Director of the Chemistry Graduate Program. However, at higher administrative levels, we lack full support, in some cases due to upper management decisions. Many times, we receive important information about fellowship opportunities for our students too late to help them apply to the program. The situation with the student enrollment process has caused many students who have enrolled to be taken out of the enrollment system and we have to enroll them again.

d. How often do administrative and support staff participate in professional improvement conferences, workshops, and seminars? Mark with a (X).

- ☐ Monthly
- ☒ Semester
- ☐ Annually
- ☐ Other _____

e. What activities and strategies has the program developed in the past five years to promote the professional development of administrative staff?

None. The administrative assistant works under the supervision of the Assistant Dean of Graduate Studies and Research of the College of Natural Sciences.

f. What has been the impact of the professional improvement activities offered in promoting the efficient operation of the Program and improving the services it offers? Have the activities been adequate and sufficient?

We are not aware of which have been the professional development activities taken by

our current assigned administrative assistant. We have sent to the Assistant Dean of Graduate Studies and Research of the College of Natural Sciences a list of the tasks which our former administrative assistant used to fulfill to try to obtain the list of tasks that the current administrative assistant is required to fulfill. We have been waiting to obtain this information, but so far, our request has not been responded to.

g. How often is the performance of administrative and support staff evaluated? Mark with a (X)

☐ Monthly

☐ Semester

☐ Annually

☐ Other _

☒ It is not evaluated

There is no formal evaluation system for administrative personnel. Only when the administrative personnel are asking for a promotion, a formal evaluation is done by their supervisors. The Coordinator of the program doesn't participate in this process, since he doesn't supervise the administrative assistant assigned to our program.

h. What effect do staff evaluations (if any) have on staff performance?

Since there is no formal evaluation system, we can't observe any changes in the performance of the administrative personnel resulting from any evaluations.

i. What was the level of participation of the program's faculty, support staff, and students in decision-making?

The Chemistry Graduate Program meets regularly to discuss and take decisions regarding all aspects of the program. The former administrative assistant participated in all meetings of the Chemistry Graduate Program, but the current one had not assisted yet since this person says that is not part of her assigned tasks. Two student representatives are elected by the graduate student body and participate in all meetings of the program, as well as in the program committees. Therefore, faculty and students have broad participation in decision making in the program.

j. What changes or revisions did the program make in the administrative and managerial components to ensure its effective functioning?

The Admissions Committee members accepted to be also be members of the Graduate Affairs Committee, since matters that must deal with graduate students are better deal with by the faculty members that have known the students since they apply to the program. The Student Learning Assessment Committee stopped working right after Hurricane María and was not able to continue the assessment process until one year later.

3. Faculty

a. Does the Program have a Faculty Recruitment and Development Plan?

☒ Yes. Answer: How effective has it been?

Although we have a well-structured recruitment plan (see Appendix 1), the University

has not honored, even partially our recruitment plan.

To maintain the Department's productivity on publications and approved grants, the recruitment plan seeks to replace retired and leaving faculty. The newly recruited professors also help meet the teaching needs of the undergraduate program.

Does that plan consider faculty retirement and changes in emphasis in the area of study? (Include a copy of the Plan in the appendixes)

☒ Yes. The Department of Chemistry and especially the Graduate Program has experienced a significant decrease in its roster of research professors. Due to retirement, we lost professors Rafael Arce (physical chemistry), John Soderquist (organic chemistry), Osvaldo Rosario (analytical chemistry) and José Prieto (organic chemistry). We also lost Professor Reginald Morales due to unexpected death and professor Pascuale Fulvio (physical chemistry) due to resignation.

□ No. Answer: ¿What are the practices and procedures for the recruitment of faculty?

b. Are the practices and procedures related with the intention of recruiting the most suitable personnel according to the development goals, objectives and expectations of the Program and the Campus?

The Department of Chemistry and especially the Graduate Program has experienced a significant decrease in its roster of research professors. Due to retirement, we lost professors Rafael Arce (physical chemistry), John Soderquist (organic chemistry), Osvaldo Rosario (analytical chemistry) and José Prieto (organic chemistry). We also lost Professor Reginald Morales due to unexpected death and professor Pascuale Fulvio (physical chemistry) due to resignation.

To maintain the Department's productivity in publications and approved grants, the current Recruitment Plan (2019) seeks to replace these researchers, to the extent possible. The new recruits will help meet both the research and teaching needs of the Graduate Program, as well as the Undergraduate Program. This Recruitment Plan includes an already approved position for an analytical chemist that was announced last summer (2020). This opening corresponds to an institutional commitment with the 5-million-dollar grant recently awarded by NSF-CREST (National Science Foundation-Centers of Research Excellence in Science and Technology) to Dr. Carlos Cabrera, a Professor of the Department of Chemistry. This position is still open and continues to receive applications. On the other hand, the Department is requesting six (6) new faculty positions. These are two (2) in the area of chemical education, two (2) in organic chemistry, one (1) in biochemistry and one (1) in physical chemistry. It should be noted that these positions have at the moment been requested, but that they have not been approved yet by the Institution.

c. What problems does the Program face when recruiting professor?

The biggest problem the Program faces when it comes to recruiting research faculty is not being competitive in either the salary or the seed fund package or the salary of graduate students, all of whom are far below of the norm in institutions with a “ranking” like ours. Travel funds, sabbatical leave, and seed funds for the recruitment of new faculty are limited and informally administered. These funds in the best of cases are not competitive when compared with the graduate programs whose classification we aspire to achieve. According to a recent Burroughs Wellcome Fund survey institutional offers

of start-up support (excluding salary) for Ph.D.s averaged $800,000 (range $500,000 to $1,400,000), with a median of $750,000. The initial offer in seed funds includes for two-three years period salary of a postdoctoral student, including benefits, salary for two graduate students, salary for the professor for the two summer months, funds for trips to participate in annual meetings and funds for instrumentation and materials according to the researcher's area of research and needs (Glassdoor "Salaries and benefit Reports," accessed on 12/18/20, available at Glassdoor.com/research).

On the other hand, the salary offered to students recruited as teaching or research assistants is not competitive; Currently it is $8,720 at the master's level and $10,900 (for ten months) at the doctoral level, which does not allow to attract the best national and international students to the Program. Our students' salaries and benefits do not compare to what is offered by other programs. According to a recent Glassdoor survey, the average base pay for a Teaching Assistant is $24,575/yr. ranging from $18 K to $37 K. (Glassdoor "Teacher Assistants Salaries Reports," accessed on 12/18/20, available at Glassdoor.com/research. In addition, the 2019 Graduate Program Survey Preliminary Results from the ACS Committee on Professional Training shows that the average teaching assistantship stipends in 2018-2019 were well over $20,000/year. Of the nine (9) regions that the US territory was divided in terms of presenting these results, the region with the lowest average TA stipends was $22,313.00/year and the region with the highest average TA stipends was $30,237.00/year.[24]

d. List your professor recruitment priorities for the next five years.

The recruitment priorities for the next five years are to recruit at least on new tenure-track assistant professor in the areas of Organic Chemistry, Physical Chemistry and Biochemistry. We have recently recruited a new Assistant Professor in Analytical Chemistry that will start in a tenure-track position in August 2021.

4. Permanent Committees

a. **What are the Permanent Committees that the Program has?**

The Program's Permanent Committees are the Admissions Committee, the Graduate Affairs Committee, the Graduate Academic Affairs Committee, the Assessment of Student Learning Committee, and the new Graduate Curriculum Review Committee.

b. Do the Standing Committees have bylaws or internal regulations that regulate their operation?

No, although each committee has a clear vision of their goals and duties.

c. Do they fulfill their functions, work plans and tasks that are proposed annually?

Every committee works efficiently and fulfills the tasks proposed annually.

d. What have been the measures proposed and implemented by the different exiting Committees and their effectiveness in achieving the goals and objectives of the Program?

[24] ACS-CPT private communication

The Graduate Academic Affairs Committee, the Assessment of Student Learning Committee, and the new Graduate Curriculum Review Committee have developed new initiatives, including the proposal for a new M.A. Chemistry Program and the revision of the M.S. and Ph.D. programs. In addition, they have worked on a curriculum revision.

e. Does the Program have an External Advisory Board or Committee? What is the impact of this external component on the achievement of the goals and objectives of the Program and its sustained improvement?

The Chemistry Graduate Program does not have an external review committee, but our 5-year Development Plan will include the establishment of an External Advisory Committee.

B. Relationships with the Community

1. What changes or revisions did the Program make to harmonize the curriculum and educational experience with institutional goals and the needs and expectations of the community?

   As part of the revision of the graduate program, students will be provided with an alternative to perform internships or practices instead of being a research assistant. These internships or practices can be completed at non-profit organizations or government agencies that serve communities. With this curricular change our students can contribute to attend communities needs

2. How is the connection and contribution of the Program to the needs and expectations of the community evidenced?

   All research proposals submitted by our faculty include an outreach and educational component to link our research and program to the community. In addition, existing research initiatives have interventions with communities and public schools, including the NASA PR-SPRInT, NSF-CREST CIRE^{2}N and NSF-PREM CIE^{2}M research programs.

3. Is there evidence of links between the Program with the private and government sectors? Through what initiatives are they being maintained?

   There are some collaborative agreements (MOU) that vinculated our Department, or some researchers with the private sector. There an MOU between the UPR X-ray Diffraction Facility, created by two our faculty members, and the Materials Characterization Center that enables services to the industry for the analysis of pharma samples. The Materials Characterization Center (MCC) is a non-profit corporation affiliated with the University of Puerto Rico. This organization provides state-of-the-art analytical services and the corresponding scientific and technical expertise for industry, academia, and government. The MCC facilities are located at the new UPR-Molecular Sciences Research Center (MSRC) and the UPR-Río Piedras campus Facundo Bueso building.

4. Through what specific initiatives or projects does the Program maintain its direct and collaborative relationship with other units of the UPR System and the Campus?

   There exist several research initiatives through which our program collaborates with other UPR campuses. Some examples are with UPR- Mayagüez campus (NASA PR-SPRInT and NSF-CREST CIRE^{2}N research programs) while the NSF-CREST CIRE^{2}N program has collaboration with the UPR-Cayey campus Physics Department. Several of our graduate student have in their thesis committees, faculty from the UPR-Biology Department, UPR-

Environmental Sciences Department, UPR-Physical Sciences Department, and the UPR-Medical Sciences Campus.

5. To what extent did the program incorporate students and staff into public professional service opportunities, prosocial alternatives, community projects, and internships?

   Through the Chemistry Graduate Association our graduate students participate in community outreach events, such as the annual American Chemical Society's (ACS) Chemists Celebrate Earth Week and the ACS National Chemistry Week. Several of our graduate students also participate in NanoDays, an annual event highlighting the uses of nanotechnology in research and our daily life, run by our NSF-CREST CIRE^{2}N and NSF-PREM CIE^{2}M programs. In addition, the MRSC holds a biannual Open House where school children, teachers, and the public can learn about the research and scientific work being performed at the center. Several of our faculty members have laboratories at the MRSC.

   Two of our graduate students were awarded the Chateaubriand Fellowship from the France Embassy in Washington, DC and were able to do internships at chemistry laboratories in France for several months. A cotutelle MOU was signed between the University of Nantes, France, and UPR-Río Piedras campus to allow one of these students to received Ph.D. degrees from both institutions.

   Several students have been in internships at the Brookhaven National Laboratories to conduct research in their synchrotron facility, as well as the Cornell High Energy Synchrotron Source (CHESS) in Ithaca, New York.

   Several of our faculty members have been involved in Project SEED of the ACS. This joint UPR-Río Piedras and ACS sponsored program brings low-income high school students to campus for an 8-weeks research experience in our research laboratories. Mentorship is this program is provided not only by the research faculty, but also by our graduate and undergraduate students at the different host laboratories.

6. Does the Program have or have Intramural Practice projects? If so, briefly describe them and include additional information as an attachment.

   The Program does not have and has not had Intramural Practice projects.

C. Outreach and Service

1. How does the academic management of the Program communicate the current institutional regulations? How do you achieve sustained compliance with them?

Through e-mail messages and during the Graduate Seminar Series. We achieve sustained compliance through annual monitoring of student progress.

2. How does the Program disseminate the Mission, its Goals and Objectives?

☒ Flyer ☒ Website / social networks

☐ Notice board ☒ Other: Regulations of the program

3. Through what tools does the Program achieve exposure or promote itself?

☒ Flyer

☐ Loose Sheets

☒ Electronic page

☒ Social networks

☒ Mass communication media. Which? Online open forums through Google Meet.

☐ Others _____

4. What evidence do you have of the use by the university community and the external community of the aforementioned media and dissemination strategies?

Students requesting information about how to apply to the program after obtaining information about it through those media and dissemination strategies. In addition, the number of participants in the online activities.

5. What data and information show that the program has integrated themes, research, service, and cultural management of the communities into the curriculum?

The program curriculum does not require the students to integrate themes, research, service, and cultural management of the communities, however, some individual research projects integrate community service.

6. In accordance with changes in institutional regulations and licensing and accreditation requirements, by the Board of Postsecondary Institutions (JIP for its acronym in Spanish) and the Middle States Commission on Higher Education (MSCHE), respectively, as well as in the academic offerings of the Program:

● Do you keep the information published on your virtual page correct and updated? Explain the measures that are taken to ensure compliance.

Yes. The Deanship of the College of Natural Sciences has assigned personnel to update the webpage of all academic programs and ensure compliance.

● Do you keep the information published on the admission requirements on the ApplyYourself platform correct and up to date?

Yes.

Explain the measures that are taken to ensure compliance.

The Admissions Committee ensures compliance.

● Does the information published in the Graduate Catalog of the Río Piedras Campus keep correct and updated?

Yes

Explain the measures that are taken to ensure compliance.

We send the most current information as requested by the Deanship of Graduate Studies and Research.

● Do you keep the information published on the Dean of Graduate Studies and Research website correct and up-to-date?

Yes

Explain what steps are taken to ensure compliance.

We send the most current information as requested by the Deanship of Graduate Studies and Research.

7. How correct and up to date are the catalog, records, publications, and other electronic media in which the program's links with the community are disclosed? How was their scope and impact determined?

We keep the most current and up-to-date information available,

D. Fiscal Aspects

1. Describe the operation of the Program in relation to the available fiscal resources.

   Currently the Chemistry Graduate Program has no budget assigned to it in the annual budget of the Department of Chemistry or the College of Natural Sciences. All expenses to run the program are covered by the Department of Chemistry budget. A line item in the Department of Chemistry budget for travel is reserved for use by the Chemistry Graduate Program to cover the travel expenses of the speakers invited to participate in our Graduate Seminar Series. We would also like also for the line item in the Department of Chemistry budget for solvents, dry ice, gas tanks and liquid nitrogen be reserved for use by the Chemistry Graduate Program.

   The previous Self-Study of the current M.S. and Ph.D. programs, which covered the academic years 2009-2010 to 2014-2015, described the lack of a separate budget for the Chemistry Graduate Program as a weakness of the program. Six years later, this is still the case.

   In the past, Alliances of individual researchers with industries such as Eli Lilly have allowed to bring some funds for lecturers, student scholarships, materials, and additional equipment.

2. How are the items of the Operational Budget linked to the priorities established in the Strategic Plan of the Río Piedras Campus and the Program Development Plan?

   The program does not have an Operational Budget.

3. How do the faculty and students participate in the design of the Program's Operational Budget, its use and evaluation of the results?

   The program does not have an Operational Budget.

4. Does the Program has a plan to identify and request external funds?

   The College of Natural Sciences regularly send notifications of available sources of external funds to encourage faculty to identify and request external funds.

5. How diverse is the Program's tax revenue portfolio?

   Non existent.

6. What initiatives does the Program contemplate to raise additional fiscal resources?

   A proposal to establish a fee-based summer camp program for high-school and middle-school students was presented to the Deanship of Graduate Studies and Research and is still under consideration. In addition, an alliance with the Division of Continuing Education and Professional Studies (DECEP for its acronym in Spanish) is being considered to offer workshops to teachers for a fee. Those resource would complement our current fiscal resources.
7. What external resources did the Program obtain for its operation and continuity and what was its impact?

   None.

8. How sufficient were the fiscal resources available to achieve the goals and objectives of the Program and the development of strategic initiatives that need to be institutionalized?

   The fiscal resources need to be improved to better achieve the goals and objectives of the program. The proposal sent to the Deanship of Graduate Studies and Research and Division of Continuing Education and Professional Studies (DECEP for its acronym in Spanish).

E. Development plan

1. This section requires the preparation or updating of a specific Development Plan to execute the actions that arise from the findings in the self-study.

The Plan format consists of a table that includes, as a minimum, the following sections:

- Critical areas and areas of excellence to be developed, duly identified
- Program goals (priorities) for each critical or developing area
- Measurable objectives (concrete actions)
- Specific activities to attend to each critical area or to develop and strengthen areas of excellence
- Appointment of person / s responsible for executing or supervising specific activities and the allocation of resources
- Date or time stipulated to carry out the specific objectives and activities
- Indicators and achievement metrics
- Budget required

2. Does the Program currently has a Development Plan? If the answer is yes, include it as an attachment.

Yes, the Program currently has a Development Plan (Appendix 8). As part of this new Self-Study, the Program will update its 5-year Development Plan by September 2021 based on the Self-Study results.

3. How do the constituents of the Program participate in the analysis and discussion of the findings of the self-study?

The constituents of the Program participated in the surveys conducted as part of the Self-Study. The draft of the Self-Study report was sent to all constituents for evaluation and

recommendations. The findings are discussed and analyzed in meeting of the faculty of the Program.

4. Have the Program expectations been discussed and approved by the Program faculty?

Yes. The expectations of the five-year development plan were distributed, discussed and approved by the faculty of the program.

H. What mechanisms have been used to discuss and disseminate the Development Plan among the faculty of the Program?

The five-year development plan was distributed, discussed, and approved by the faculty of the program. The five-year report about the implementation of the plan will also be distributed, discussed, and approved by the faculty of the program.

APPENDIXES SECTION