External Review

Department of Computer Science
Lehman College

September 15th, 2023

Summary

Our review of the Department of Computer Science at Lehman College results in four primary findings:

- **Finding 1:** Over-Enrollment in Introduction to Computer Science must be addressed
- **Finding 2:** The Master's in Computer Science's lack of graduate-only course listings limits its ability to serve graduating Lehman College undergraduates
- **Finding 3:** The Computer Science curriculum is thoughtfully designed, aligned well with the needs of students, and reflects the constraints the department operates under
- **Finding 4:** Student Support services provided to Lehman College computer science students is commendable and is a strength of the program.

These findings were made through extensive review of all materials provided to the external review team by the Lehman College faculty and through interviews conducted during the on-site visit in June of 2023.

Recommendations:

Findings 1 and 2 identify areas for improvement, and in both cases an increase in the number of faculty lines is critical to remediation. In addition, commitment to faculty **retention** should be prioritized. We also recommend review of classroom allocation, as a consistent theme when meeting with Lehman College students was a lack of adequate classroom space to serve the large class sizes in the introductory level Computer Science courses.

Finding 1: Over-Enrollment in Introduction to Computer Science must be addressed.

The Introduction to Computer Science course is routinely over-enrolled, with class sizes well exceeding what the faculty, students, and consensus among higher education professionals recommend. This problem was identified through interviews conducted with both faculty and students and through review of enrollment materials provided.

Over-enrollment in introductory courses has created two distinct problems:

1. Significantly reduced pass rates among first year computer science students, resulting in steep drop offs in retention. Computer Science is best taught through interaction with students, hands-on learning, and tight feedback loops between instruction, performance, and review. This is not possible when class sizes are in triple digits without the support of instructional assistants.
2. Inadequate classrooms for large class sizes. Students and faculty reported that students often do not have chairs in the classroom, and that large computer science sections are routinely taught *without* screens and projectors for instruction. This is simply not effective in a computer science classroom, and contributes to reduced pass-rates and retention issues.

During interviews, faculty identified administrative pressure to increase passing rates among first year students. While this is clearly an important objective, we note that this **cannot be achieved through modified requirements and expectations**. All Computer Science curriculums contain lengthy prerequisite stacks, because courses are simply not independent of each other. Foundational skills developed in an Introductory Computer Science course are **required** in each subsequent course throughout the curriculum. Students with insufficient skills after their first year **will struggle to graduate**, and **struggle to put their degree to use**. Any attempt to artificially increase passing rates among first year students that does not directly address the learning deficits causing the low passing rate will result in falling graduation rates among Computer Science students - an outcome that must be avoided. In addition, if learning deficits are not addressed, students may graduate without the advanced skills required by employers in the technology sector.

Over-enrolled classes at the introductory level must be addressed by an increase in the number of sections offered. Having reviewed the course content, there is no reason to doubt that a reduced class size will result in a higher number of students exiting their first year prepared for the remainder of the Computer Science curriculum. Smaller class sizes may also aid in addressing classroom shortcomings.

We recommend that staffing levels be reinforced to support an increase in the number of introductory sections offered each academic year, without reducing the number of middle and upper level sections offered.

Finding 2: The Master's in Computer Science's lack of graduate-only course listings limits its ability to serve graduating Lehman College undergraduates

The enrollment within the Master's in Computer Science program was found to be significantly low, with diminishing prospects of recovery. A Master's in Computer Science is a marketable degree, however Lehman faces significant competition in this space - it is a very common degree offered at most institutions.

The primary deficiency we found, through review of the curriculum and departmental data, along with faculty interviews, was in the level of coursework being offered. The prevalence of undergraduate and graduate courses being **cross-listed** or dually enrolled by both undergraduates and graduate students was **severely** out of balance - with too many courses falling into this category.

The motivation of cross-listing is obvious, this is a technique used to address instructional staffing issues at many institutions. When used sparingly, this approach can help offer students additional choice in coursework and benefits both the undergraduate and graduate programs. At Lehman, however, the curriculum of the graduate program overlaps so significantly with undergraduate courses that there is little marketable differentiation between the programs. This creates two problems:

1. The MS program is not attractive to students who are new to Lehman (post-baccalaureate) due to lack of advanced coursework.
2. The MS program is not attractive to Lehman undergraduates considering staying at Lehman for graduate school, as they will have frequently **already taken** many of the graduate courses being offered.

The high level of overlap also creates missed opportunities. 4+1 programs, where students can earn a BS and MS degree in Computer Science in five total years are becoming a widely common and popular option for students at many universities. With the current level of overlap between the BS and MS coursework, there is no practical way for Lehman to build such a program, there are simply not enough distinct courses for most students to attain both degrees.

Through discussion with faculty, our conclusion is that the MS in Computer Science must either (1) create and offer more courses distinct for graduate students, or (2) consider discontinuing the program or drastically changing its structure.

We recommend that staffing levels be reinforced to support an increase in the number of graduate courses that can be offered exclusively to graduate level students in order to revive the MS program at Lehman.

Finding 3: The Computer Science curriculum is thoughtfully designed, aligned well with the needs of students, and reflects the constraints the department operates under

One of the strengths of the Lehman College computer science program is the careful attention that has been paid to curriculum design that meets the needs of the students. In particular, there is a strong assessment program in place which includes the key step of closing the loop – that is, using the data on a regular, scheduled basis to improve the curriculum and teaching approaches.

As reported in the self-study and in the interviews, the students in the computing programs at Lehman College are different from the typical undergraduate student. They are commuters, somewhat older, likely to be working at outside jobs, and often have parenting commitments. At Lehman overall, the majority of students are eligible for Pell grants, speak a language other than English at home, and are first in their family to attend college. In addition, they often have gaps in high school preparation, especially math, and are less likely to have studied computing in high school. This leads to significant challenges in getting students through a difficult major in just four years and ensuring they have the skills and knowledge that will lead to employment in the technology sector. However, the faculty in the computer science department are mission driven and dedicated to their students and have used best practices in assessment and continuous improvement to design a quality program that reflects their students' needs.

Three degree programs are offered:

- a BS in Computer Science with a current requirement of 60 credits and a planned expansion to 80 credits.
- A BA in Computer Science which is limited to students doing a second major
- A BS in Computer Information Systems with a requirement of 58 credits, focusing on use of computing in organizations rather than on software development and algorithms.

There is also a MS program in Computer Science as well as a minor. This section of the report concentrates on the two BS programs which are the centerpieces of the department. The BS in Computer Science offers solid coverage of both programming topics and advanced computer science topics. It is reasonably aligned with the most recent ACM curriculum recommendation (2013). If the department decides at some point to pursue ABET accreditation, some additional required courses may need to be added, in particular a required course in theoretical computer science, a second data structures and algorithms course, and a cybersecurity course. These courses already exist but are currently electives. The Computer Information Systems course also appears to be aligned with the most recent ACM curricular recommendations for Information Systems (2020). One issue that cropped up in the interviews is that since the Math and Computer Science departments were split, the responsibility for teaching some of the math courses has now fallen on computer science faculty, who are already overloaded with computer science courses. Another concern, which comes from comments in the student surveys in the Self Evaluation Report, is lack of support for career planning, successfully finding jobs, and relevance to job related skills at the course level. The department already offers an independent study in technical interviewing skills, which is very useful and often ignored in many computer science programs. Perhaps this could be expanded into a full 3 credit course that focuses on preparing for employment in the technology sector. One other issue that was mentioned in interviews and in the student survey is that courses are sometimes not available. This is likely due to the understaffing in the department but needs to be addressed because course availability can be a real obstacle for students trying to graduate on time.

Because of weaknesses in student preparation, as well as large class sizes, there appear to be considerable difficulties in successfully moving students through the introductory programming sequence while ensuring high enough standards to make sure they do not fail in subsequent

courses. This is an issue in many computer science programs of course, because upper level courses depend so heavily on skills acquired in the introductory sequence, and because employers have very high expectations of computer science graduates. The faculty in the computer science program have worked very hard to address this problem, focusing on course level assessment and on standardization of the introductory sequence.

The assessment methods used in the computer science department are well planned and extensive. The Computer Science and Computer Information Systems majors have program level outcomes. Each course has its own learning outcomes which are explicitly aligned to the program outcomes. One faculty member oversees assessment efforts and receives reassigned time for this work. Advanced courses are assessed by individual instructors based on questions on the final exam on a periodic basis. There is a lot of emphasis on assessment of the introductory 3 course programming sequence, which appears to be done every year by a committee. Formal assessment reports track results and plans for improvements based on the results, in effect “closing the loop”. Assessment of the introductory sequence appears to be increasingly data driven, especially after adoption of a teaching approach that uses a platform that collects data at a very fine-grained level, allowing student performance on reading, participation and homework to be tracked as well as final exams and final grades.

The other focus has been on content changes and standardization in the introductory sequence. This effort has been informed by assessment results. The existing problem in the introductory sequence is that since the courses are taught by a wide range of both faculty and adjuncts, there were wide differences in standards and content. This is a common problem in programs that have many sections of the introductory courses, but it can lead to wide variance in students’ level of preparation for advanced courses. Over the years, the department has tried different programming languages and different levels of standardization and has come to the conclusion that all sections of the three courses must be unified, with the same syllabi and content taught in every section. The current approach is to have one unified lecture with many small lab sections for completing the programming assignments. This ensures that students are all receiving the same level of preparation. One problem with this approach which was mentioned in the student interviews is that there does not seem to be a room that is well suited for the very large unified lecture, meaning it is hard for students to see and hear in the room. They also felt it was hard to get personal attention in such a large class. The department might consider keeping the unified content, lab sections, and syllabi, but breaking up the lecture into somewhat smaller sections. This of course would require more staffing which seems to be a central problem for many aspects of the department. Still, the focus on data collection, assessment, and standardization in these three critical courses is a real strength for the department.

We recommend that staffing levels be reinforced to support an increase in the number of introductory lecture sections offered each academic year, while continuing the unified content approach and the separate lab sections. In addition, we recommend that the current assessment and improvement approach be continued.

Finding 4: Student Support services provided to Lehman College computer science students is commendable and is a strength of the program.

The students in the computer science programs face many external challenges, due to lack of academic preparation, financial challenges, family obligations, and the need to work. As a result, they need more support than students at more traditional universities. It is clear that the faculty and staff in the computer science program are whole-heartedly dedicated to this student population and to the mission of Lehman College. This was stated in interview after interview with the faculty and was also reflected in the student comments when they were interviewed. As a result, there are a number of strengths in the departmental services provided to students. There is a coordinator who oversees the extensive tutoring effort, which is housed in a CS lab. The coordinator also works with a student technology club and organizes career-focused workshops for students. The students who were interviewed were happy with the extracurricular activities and mentioned that if there was more space, they could do even more. The department also participates in an internship program with IBM and with the NYC Tech Talent Pipeline which sets up short term placements for students with NYC tech companies. In addition, Lehman College participates in the CUNY Inclusive Economy Initiative, which will be housed in the computer science department. This will connect students to industry through advising and internships.

Tutoring is a key support service for students in computer science, especially when class sizes are large, and it is clear that the computer science department recognizes this. One challenge for the tutoring effort is that funds to pay tutors fluctuates from year to year and often does not get approved before the semester starts, meaning that tutors cannot be hired until well into the semester. By that point, it might be too late for some students. In addition, even though the department provides a lot of tutors, there is clearly demand for even more because of the growth in enrollment. Overall, though, the attention paid to tutoring and other career-focused workshops and industry initiatives is commendable and reflects the dedication of the computer science department to the success of its graduates.

We recommend that a stable funding line for tutoring should be established, with funds available by the start of the semester so that tutors can be hired right away. In addition, the budget should be increased to fill increased demand for tutors due to enrollment growth.

Conclusions

We found the faculty within the Computer Science department to be dedicated teachers, researchers, and professionals. We were impressed by their commitment to student outcomes, and willingness to meet the demands of what appeared to be severely constrained resources. Our discussion with students was enlightening and constructive. While students identified classroom adequacy issues, they spoke highly of the faculty and the institution in general.

The recent curricular revisions, particularly moving towards a unified curriculum within all introductory courses, adoption of common course materials, and an emphasis on practical and marketable skills are commendable. We found that the faculty have created a curriculum that aligns extremely well with the needs of the students.

We have reviewed current materials provided by the department, along with previous self-studies and external evaluations. The common theme now, and in the past, is under-staffing - and we believe it must be urgently addressed. Furthermore, we are concerned with faculty retention, and the prospects of replenishment of staff. The Computer Science job market for graduating PhDs heavily favors the **applicants** - hiring new Computer Science faculty is incredibly difficult. Lehman has factors beyond its control which make hiring new faculty even more difficult - most notably the realities of public institution compensation limits. It is for these reasons that we suggest the administration carefully consider how it can better support **existing** faculty (research opportunities, support services, etc) in order to ensure attrition does not occur.

On a final note, reinforcing faculty ranks is also necessary should Lehman consider obtaining ABET accreditation in Computer Science. We understand that in the past, ABET accreditation has been an institutional priority, however the expectations of an ABET accredited curriculum would place additional staffing demands that we do not believe Lehman is positioned to meet.

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