AUBURN UNIVERSITY

PROGRAM ASSESSMENT REPORT

DOCTOR OF PHILOSOPHY IN COMPUTER SCIENCE AND SOFTWARE ENGINEERING

The Department of Computer Science and Software Engineering (CSSE) offers the Doctor of Philosophy in Computer Science and Software Engineering. The Ph.D. degree is designated with the major of computer science and software engineering. The degree requirements are prescribed by the graduate school as well as CSSE.

Core:		
COMP 7270	Advanced Topics in Algorithms	3
COMP 7300	Advanced Computer Architecture	3
COMP 7500	Advanced Topics in Operating Systems	3
Additional:		
COMP 8990	Research and Dissertation	18
Select 3 Graded Credits in COMP 7000 and above (excluding COMP7930 and COMP8930)		3
Select 27 Graded Credits in COMP 6000 and above		27
Select 9 Graded Credits in 6000 and above		9
Total Hours		**66**

A maximum of six (6) credit hours of directed study (COMP 8930) can be applied toward the degree. A maximum of 18 hours of COMP 8990 can be applied toward the degree.

The general doctoral examination consists of two parts – written and oral. The written part will be successfully fulfilled by passing the three qualifying exams (computer organization/architecture, operating systems, and algorithms) or earning a B or higher in the required core courses. In the oral part, a doctoral student will present to her/his advisory committee a thorough description of her/his proposed dissertation research. Successful completion of the oral part requires unanimous approval of the student's advisory committee. Upon successful completion of the general examination, the student advances to candidacy. After completion of the dissertation, the student must pass a final examination defending the dissertation.

For questions on the assessment report, please email Dr. Xiao Qin (xqin@auburn.edu)

Student Learning Outcomes

The vision of the Doctor of Philosophy in Computer Science and Software Engineering (PhD-CSSE) program at Auburn University is to develop doctoral students' research skills in cutting-edge computer science and software engineering disciplines. We cater to doctoral students with strong research skills and outstanding teaching skills and in computer science and software engineering.

1. Specificity of Outcomes

There are four student learning outcomes (SLO 1-4) defined to implement our PhD-CSSE program vision.

- **SLO 1:** Students will demonstrate mastery with in-depth knowledge in algorithms, operating systems, and architecture.
- **SLO 2:** Students will be able to develop and evaluate software systems to meet desired requirements.
- **SLO 3:** Students will perform cutting-edge research in at least one area of specialty.
- **SLO 4:** Students will communicate concepts and results to technical audiences in the format of conference/journal papers as well as oral presentations.

2. Comprehensive Outcomes

The four student learning outcomes (SLOs) listed in Section 1 represent the culmination of all coursework related to the PhD-CSSE program. These outcomes represent skills and capabilities that should be fully developed over the course of each Ph.D. student's education.

Although the program offers a broad education allowing Ph.D. students to improve research and teaching skills in computer science and software engineering disciplines, these SLOs represent the skills and capacities required in careers as computer scientists, researchers, and engineers.

The CSSE faculty measures the SLOs according to the proficiency guidelines offered by the Association of Computing Machinery (ACM), which is the world's largest professional organization for educational and scientific computing. In the past decade, ACM has produced a series of recommendations for university-level graduate Computer Science programs. The PhD-CSSE program has adopted the ACM recommendations as its education objectives to train well-prepared Ph.D. students. In addition, these four SLOs are in alignment with disciplinary standards set by IEEE Computer Society, Computing Research Association (CRA), and those professionals represented by ACM and IEEE.

The initial version of the SLOs was created by the CSSE graduate programs committee (5 members) through a series of discussion sessions and meetings held between April 2017 to June 2017. In May 2020, the graduate programs committee revised the SLOs; the number of SLOs was cut back from 20 down to 5. The previous version of 20 SLOs makes the program too complicated to assess. We intend to keep the current version unchanged for the next five years. The new SLOs were approved by the CSSE faculty in June 2020. The SLOs will be re-evaluated, reviewed, and ratified in the year 2025.

3. Communicating Student Learning Outcomes

3.1 Faculty

The graduate programs committee was directly involved in the development of the program vision and student learning outcomes. A copy of this assessment report will be disseminated to newly hired faculty and adjunct faculty members during the orientation week or the beginning of their first academic

semester. We have made all the assessment reports available on the department's shared drive to be accessed by all the CSSE faculty and staff members.

3.2 Students

We have provided newly admitted CSSE doctoral students with a copy of the program vision and student learning outcomes in their orientation meeting organized by the Graduate Program Officer. The orientation meetings are held in the beginning of the first semester of the program. Doctoral students are introduced to the program assessment methods used by the graduate program committee. The student learning outcomes are posted on the departmental website to disseminate the SLOs information to current and prospective doctoral students.

Curriculum Map

4. Curriculum Map for the PhD-CSSE program

The following table is a curriculum map that visually depicts the alignment between the PhD-CSSE student learning outcomes (SLOs) and the courses offered from the Fall'12 to Spring'22 semesters. In each cell of the curriculum map, a letter indicates how a course relates to a student learning outcome. Letters "I", "R", and "E" designate courses in the program "introduce", "reinforce", or "emphasize" the corresponding learning outcomes. We assign weights to represent the contributions of the graduate courses to each of the four SLOs. The weights for "introduce", "reinforce", or "emphasize" are 0.33, 0.66, and 1.0, respectively.

Contribution	Weight	Notation
• Introduce:	0.33	I
• Reinforce:	0.66	R
• Emphasize:	1.0	E

The curriculum map was initially reviewed and approved by the CSSE faculty in June 2020. In May and June 2021, the graduate faculty have further reviewed and revised the curriculum map. More than 90% of the courses in this map have been updated and ratified by the professors who offered the courses in the Summer'21, Fall'21, and Spring'22 semesters. The graduate programs committee intends to keep the curriculum maps unchanged in the next five years unless one or more learning outcomes are updated before June 2025. We will revisit and update this curriculum map in the spring 2025 semester.

The Curriculum Map of the PhD-CSSE Program

Course Outcomes	SLO 1	SLO 2	SLO 3	SLO 4
6000 Web Application Development		E		E
6120 Database Systems I	E	E	I	R
6120 Database Systems I (Summer)	I	R	R	E
6130 Data Mining	E	I	R	E
6320 Design and Analysis of Computer Networks	R	R	E	
6340 Network Quality Assurance and Simulation	I	R	E	
6350 Digital Forensics	I			
6360 Wireless and Mobile Networks	E	R	E	R

6370 Computer and Network Security	I		E	
6400 Foundation of Computer Graphics		R	1E	
6520 Network and Operating Sys Admin			E	
6530 Cloud Computing		E	I	
6600 Artificial Intelligence	R		E	
6620 User Interface Design and Evaluation		R	E	R
6630 Machine Learning	R	R	R	R
6660 Intro to Evolutionary Comp	R	R	E	R
6700 Software Process		E		
6710 Software Quality Assurance	R	E	R	E
6970 Special Topics: Comp Intel. & Adversarial ML	R	R	E	R
6970 Special Topics: Game Design for Social Change	E	I	E	E
6970 Special Topics: Cybersecurity Threats&CounterM	E	I	I	
6970 Special Topics: Cyber Physical Systems Security			R	R
6970 Special Topics: Computational Biology		R	E	E
6970 Special Topics: Deep Learning	R	R	E	R
6970 Special Topics: Game Design and Development	R	E	I	
6970 Special Topics: Information Retrieval		R	I	R
6970 Special Topics: Security in Wireless Networks	E	R	E	R
6970 Special Topics: Software Analytics		E	E	R
6970 Special Topics: iOS Development	E	R		R
7120 Database Systems II			E	E
7270 Advanced Topics in Algorithms	E	E	E	E
7300 Advanced Computer Architecture	E	R	E	I
7330 Topics in Parallel and Distributed Computing		R	E	I
7370 Advanced Computer and Network Security	E	E	E	E
7500 Advanced Topics in Operating Systems	E	R	I	I
7620 Human Computer Interaction		I	E	I
7700 Software Architecture		E		
7720 Software Re-Engineering	I			I
7800 AI for Security			E	
7950 Introduction Graduate Study Computer Science				I
7970 Natural Language Processing		R	R	E
8930 Directed Study	R	R	E	E
8990 Research and Thesis	R	R	E	E

Measurement

5. Outcome-Measure Alignment

All the student learning outcomes are assessed using a combination of pre-tests and post-tests, quizzes, midterm and final exams, written assignments, programming assignments, course projects, or presentations. A handful of rubrics have been developed to assess homework and project assignments (e.g., written communication, oral communication, projects). In addition, CSSE doctoral students are required to take

- Qualifying Exams.
- General Doctoral Examination, and
- Final Doctoral Examination.

The outcome-measure alignment is listed in the table below. Notation: QZ - Quiz, PE – Pre-test, ME – Midterm Exams, FE – Final Exams, WA – Written Assignments, PA -Programming Assignments, PT – Presentations, PJ – Projects, QF – Qualifying Exam, PD – Proposal Defense, FD – Final Defense, ID – Indirect, SV – Survey.

The outcome-measure alignment for the PhD-CSSE Program

Outcomes	QZ	PE	ME	FE	WA	PA	PJ	PT	QF	PD	FD	ID	SV
SLO 1	X		X	X	X	X			X				
SLO 2		X	X	X			X						
SLO 3					X		X	X		X	X		
SLO 4							X			X	X	X	X

6. Direct Measures

Each student learning outcome has a list of direct measurements. Direct measures, requiring Ph.D. students to demonstrate their knowledge and skills, will provide tangible, visible and self-explanatory evidence of what our Ph.D. students have and have not learned as a result of graduate courses and the Ph.D. program. In this section, we elaborate on various ways of measuring actual student behaviors.

- Authentic Course-Embedded: Exams, Quizzes, Oral Presentations, Assignments, Projects.
- Discipline Specific Test 1: Ph.D. Qualifying Exams.
- Discipline Specific Test 2: General Oral Examination (Proposal Defense).
- Exit Exams: Final Oral Examination (Final Dissertation Defense or Dissertation Defense).

6.1 Authentic Course-Embedded Measures

This type of direct measures includes exams, tests, quizzes, oral presentations, quizzes, assignments. We believe the direct measures in this category are most effective because the measures are course-embedded, which means the work accomplished by our Ph.D. students are actually work that counts towards a grade. Our Ph.D. students are likely to take the learning activity more seriously if associated with grades. We directly gauge student knowledge and skills by the virtue of authentic and part of already existing student work. The disadvantage of this method is two-

fold: it is immensely time-consuming, and it is difficult to collect data to forge an annual assessment report. For this reason, we also rely on the following three direct measures of student learning.

6.2 Discipline Specific Assessment 1: Ph.D. Qualifying Exams

Doctoral students are required to take the three qualifying exams to demonstrate knowledge of computer science fundamentals and potential for Ph.D. studies. The qualifying exams are comprised of two phases: (I) written exams and (II) a remedy course requirement. All doctoral students must be in good academic standing at the time when the qualifying exams (i.e., Phases I and II) are completed.

Timeline. Doctoral students have one and a half years to pass the qualifying exams. Distance education doctoral students have two and a half years to pass the qualifying exams if they are enrolling in three or fewer credit hours per semester. The three-hour written exams are given twice a year, namely, (1) in August right before the start of the Fall semester, and (2) in January right before the beginning of the Spring semester.

Phase I: Written Exams

Three Topic Areas. The exam consists of three distinct components, each of which covers one of the following three specific course topics. No reference material is allowed in the exam, although examinees may use a nonprogrammable calculator.

- Operating Systems (Aligned to Outcome 1)
- Computer Organization and Architecture (Aligned to Outcome 1)
- Algorithms (Aligned to Outcome 1)

Passing Phase I. Written exams are graded by the graduate committee, the chair of which (i.e., graduate program director) notifies the students of their exam results. Doctoral students must score more than 70 percent on an exam component to pass the exam component. Students passing all three exam components are considered fully qualified to pursue further graduate studies. Such students have no obligation to move towards Phase II. Students passing Phase I may take COMP 7270/6, COMP 7300/6, and COMP 7500/6 as elective courses.

Proceeding with Phase II. Students scoring more than 30% but less than 70% on an exam component must proceed to the next phase (i.e., the remedy course requirement) to pass the qualifying exams.

Dismissal from the Ph.D. Program. Students with a score of 30% or less on any exam component are dismissed from the doctoral program.

Phase II: Remedy Course Requirement

Three Courses. Students scoring more than 30% but less than 70% on an exam component must take the corresponding remedy course within one year after taking the exams. The three remedy courses for the areas of operating systems, computer architecture, and algorithms are:

- COMP 7500 (Advanced Topics in Operating Systems)
- COMP 7300 (Advanced Computer Architecture)
- COMP 7270 (Advanced Topics in Algorithms)

Exemption. Students passing any exam component are exempted from taking the corresponding remedy course. For example, if a student passes the written exam of operating systems, the student will be

exempted from taking COMP 7500 Advanced Topics in Operating Systems.

Passing Phase II. Doctoral students in Phase II will have to receive a grade of 'B' or higher in each required remedy course to pass the qualifying exams. Students receiving a grade of 'C' or 'D' in any remedy course must retake and pass (i.e., a letter grade of 'B' or higher) that course the following year. Students passing remedy courses on the first or second attempt are considered fully qualified to pursue further graduate studies.

Failing in Phase II. Students who fail to meet the remedy course requirement in Phase II will be dismissed from the Ph.D. program.

6.3 Discipline Specific Assessment 2: General Oral Examination

Successful completion of a general examination (also referred to as the "Preliminary Examination" or "Proposal Defense") over the student's major and minor areas is required to become a Ph.D. candidate. This milestone signals that the student is in the research phase of the degree and has selected an acceptable research topic. The examination shall be administered by the student's advisory committee in accordance with the Auburn University Bulletin. Before this examination can be taken, the student must have:

- Satisfied the academic qualifying process
- Submitted a formal research proposal
- Satisfied publication requirements

The portion of the examination during which the student presents a research topic is open to the public. The student should give an abstract of the research proposal to the departmental secretary at least one business day in advance of the examination for dissemination to the CSSE graduate student body.

6.4 Exit Assessment: Final Oral Examination

The final oral examination (also referred to as the "dissertation defense" or "final defense") takes place at the conclusion of a doctoral student's research. Successful completion of the final examination is required of all students before earning the Ph.D. degree. The examination will be administered by the candidate's advisory committee in accordance with the Auburn University Bulletin. Before this examination can be taken, the student must have satisfied all the other requirements for the Ph.D. degree.

The doctoral student is required to submit his or her draft dissertation to the supervisory committee to review at least two weeks prior to the examination. More often than not, the committee members will offer insightful and constructive comments on the dissertation. The student will incorporate the review comments to future improve the overall quality of the dissertation.

The final doctoral examination is open to the public. The doctoral student should give an abstract of the dissertation to the departmental secretary at least one business day in advance of the examination for dissemination to the CSSE graduate student body.

7. Data Collection

CSSE graduate faculty members have taught a total of 33 graduate-level courses in the academic year 2021-2022. At the end of the spring 2022 semester, the director of graduate programs (GPO) designed a course-

level data collection form (see also Section 8 on page 8) shared on the Google Spreadsheet. After the data-collection requests were sent to the instructors, the data collection spreadsheet was collaboratively updated by the CSSE graduate faculty. The response rate is higher than 90%.

For all the four student learning outcomes, individual faculty members collect data for the graduate courses, usually in a wide variety of forms (e.g., quizzes, exams, assignments, course projects, and presentations). The examinations consist of a series of questions administered in class at the end of the semester. The quiz and exam answers are reviewed by the faculty members and reported to the assessment coordinator.

In each graduate course, the faculty member aligned at least one of the direct measures - exams, tests, quizzes, oral presentations, quizzes, and assignments - to at least one of the four student learning outcomes. For each direct measure in a graduate course, student performance ratings are categorized in five camps depending on score ranges:

Direct Measure Rating	Score Range	Notation
• Outstanding Mastery:	[90, 100]	OM
• Above Satisfactory Mastery:	[80, 90)	AM
• Satisfactory Mastery:	[70, 80)	SM
• Partial Mastery:	[60, 70)	PM
• Minimal or no evidence of Mastery:	[0, 60)	MM

The table below includes all relevant information with regards to how the direct assessment was conducted and the rationale for choosing specific measurement methods.

The Detailed Information on Direct Assessment Methods

Learning Outcomes	SLO 1	SLO 2	SLO 3	SLO4
Direct Measure Description	Exams and Quizzes	Programming Assignment and Projects	Assignment and Projects	Presentations and Written Reports
Samples	All students enrolled in COMP 7270, 7300, 7500, 6120, 6320, 6360	All students enrolled in COMP 6000, 6120, 6530, 6700, 7370, 7700	All students enrolled in COMP 6320, 6340, 6370, 6600, 6620, 6970	All students enrolled in COMP 6120, 6130, 6970, 7120, 7370, 7970
When	Final exam week; fall and spring semesters	Last week of fall, spring, and summer semesters	Last week of fall and spring semesters	Presentation weeks of fall and spring semesters

Where	Final Week and In-Class or Canvas	Canvas	Canvas	Canvas
How	Faculty or GTA graded	Faculty or GTA graded	Faculty or GTA graded	Faculty or GTA graded
Desired Results	The class average should be rated as "Outstanding Mastery"	The class average should be rated as "Outstanding Mastery"	The class average should be rated as "Outstanding Mastery"	The class average should be rated as "Outstanding Mastery"

Each course's score is derived from the above direct measures. Importantly, the enrollment of a course is treated as the course weight during the data aggregation process, meaning that a course with high enrollment contributes to the final SLO scores more significantly than those with low enrollments. Recall that the curriculum map articulated in Section 4 on page 3 indicates that each course has impacts on one or more SLOs. Such impacts are measured in terms of "introduce" (I), "reinforce" (R), or "emphasize" (E). To aggregate course-level data, we assign 1.00, 0.66, and 0.33 to "introduce" (I), "reinforce" (R), or "emphasize" (E) in the curriculum map. We apply this assignment strategy because a course that "emphasize" on a SLO offers more pronounced contributions than another course rated as "introduce".

SLO 3 - student capabilities to perform cutting edge research in at least one area of specialty – is assessed through two types of research-oriented courses, namely, COMP 8930 directed studies and COMP 8990 dissertation and research. A rubric for each course project is provided to help identify areas where students' capability needs improvement.

In a general oral examination (Discipline Specific Test 2, see also Section 6.3 on page 7), the student's supervisory committee members complete a direct measure to assess the student's knowledge and research skills before the student becomes a Ph.D. candidate.

Oral and written communication skills (SLO 4) are assessed throughout course projects, directed studies, research and thesis, starting with the introductory course. Rubrics are used to assess both written and oral communication skills during software development lifecycles. The faculty members complete the rubric distributed to students to improve their communication performance. All scores for written reports and presentations are collected by the assessment coordinator at the end of each semester.

All the doctoral students are required to complete dissertation research projects and write a dissertation. A student's supervisor completes a performance evaluation form to assess the student's communication, research, and software development skills. The survey is provided as a google document, which is completed either offline or online. To offer feedback to the doctoral students, evaluations are completed at mid-semester with results reported to the student. Final evaluations are completed at the end of each semester collected by the assessment coordinator.

Results

8. Reporting Results

8.1 Direct Assessment Results of the Four SLOs

Recall that in each graduate course, the faculty member aligned at least one of the direct measures - exams, tests, quizzes, oral presentations, quizzes, and assignments - to at least one of the four student learning outcomes. Given direct measures in the graduate courses, the instructors rated student performance in the following five categories depending on score ranges.

Direct Measure Rating	Score Range	Notation
• Outstanding Mastery:	[90, 100]	OM
• Above Satisfactory Mastery:	[80, 90)	AM
• Satisfactory Mastery:	[70, 80)	SM
• Partial Mastery:	[60, 70)	PM
• Minimal or no evidence of Mastery:	[0, 60)	MM

The table below summarizes the course-level assessment results. The score of each course is mapped to the four SLOs according to the curriculum map delineated in Section 4 on page 3.

The Direct Measurement Data for the PhD-CSSE Program

Course			PhD	Students		
		A	B	C	D	F
COMP 6000	# of Students	4	0	0	0	0
Marghitu	% of Students	100.0%	0.0%	0.0%	0.0%	0.0%
			Score	100.0	Count	4
COMP 6120	# of Students	5	0	0	0	0
Ku (Spring/Fall)	% of Students	100.0%	0.0%	0.0%	0.0%	0.0%
			Score	100.0	Count	5
COMP 6210	# of Students	1	0	0	0	0
Mulder	% of Students	100.0%	0.0%	0.0%	0.0%	0.0%
			Score	100.0	Count	1
COMP 6130	# of Students	3	0	0	0	0
Zhou	% of Students	100.0%	0.0%	0.0%	0.0%	0.0%
			Score	100.0	Count	3
COMP 6320	# of Students	3	2	0	0	0
Shu	% of Students	60.0%	40.00%	0.0%	0.0%	0.0%
			Score	90.0	Count	5
COMP 6350	# of Students	0	0	0	0	0
Cuneo	% of Students					
			Score	0.0	Count	0

COMP 6360	# of Students	0	0	0	0	0
Lim	% of Students					
			Score	**0.0**	**Count**	**0**
COMP 6370	# of Students	0	0	0	0	0
Springall	% of Students					
			Score	**0.0**	**Count**	**0**
COMP 6520	# of Students	0	0	0	0	0
Umphress (Summer)	% of Students					
			Score	**0.0**	**Count**	**0**
COMP 6530	# of Students	0	0	0	0	0
Sardinas	% of Students					
			Score	**0.0**	**Count**	**0**
COMP 6600	# of Students	0	0	0	0	0
Liu	% of Students					
			Score	**0.0**	**Count**	**0**
COMP 6620	# of Students	0	0	0	0	0
Seals	% of Students					
			Score	**0.0**	**Count**	**0**
COMP 6630	# of Students	4	1	0	0	0
A. Nguyen/Karmaker	% of Students	80.0%	20.0%	0.0%	0.0%	0.0%
			Score	**95.0**	**Count**	**5**
COMP 6660	# of Students	2	1	0	0	0
Tauritz	% of Students	66.7%	33.3%	0.0%	0.0%	0.0%
			Score	**91.7**	**Count**	**3**
COMP 6700	# of Students	0	0	0	0	0
Umphress	% of Students					
			Score	**0.0**	**Count**	**0**
COMP 6710	# of Students	0	0	0	1	0
Rahman	% of Students	0.0%	0.0%	0.0%	100.0%	0.0%
			Score	**25.0**	**Count**	**1**
COMP 6970-CTCM	# of Students	0	0	0	0	0
Cuneo	% of Students					
			Score	**0.0**	**Count**	**0**
COMP 6970-CPS	# of Students	3	0	0	0	0
Yampolskiy	% of Students	100.0%	0.0%	0.0%	0.0%	0.0%
			Score	**100.0**	**Count**	**3**
COMP 6970-BPA	# of Students	1	0	0	0	0
Mulder	% of Students	100.0%	0.0%	0.0%	0.0%	0.0%
			Score	**100.0**	**Count**	**1**
COMP 6970-GDSC	# of Students	0	0	0	0	0

Thomas	% of Students					
			Score	**0.0**	**Count**	**0**
COMP 7970-Research EC	# of Students	0	0	0	0	0
Tauritz	% of Students					
			Score	**0.0**	**Count**	**0**
COMP 6970	# of Students	1	0	0	0	0
Heaton	% of Students	100.0%	0.0%	0.0%	0.0%	0.0%
			Score	**100.0**	**Count**	**1**
COMP 6970	# of Students	0	0	0	0	0
A Nguyen	% of Students					
			Score	**0.0**	**Count**	**0**
COMP 6970	# of Students	0	0	0	0	0
Seals	% of Students					
			Score	**0.0**	**Count**	**0**
COMP 6970-IR	# of Students	3	0	0	0	0
Karmaker	% of Students	100.0%	0.0%	0.0%	0.0%	0.0%
			Score	**100.0**	**Count**	**3**
COMP 6830	# of Students	0	0	0	0	0
Springall	% of Students					
			Score	**0.0**	**Count**	**0**
COMP 6970	# of Students	0	0	0	0	0
Sardinas	% of Students					
			Score	**0.0**	**Count**	**0**
COMP 8930	# of Students	6	0	0	0	0
	% of Students	100%	0.0%	0.0%	0.0%	0.0%
			Score	**100.0**	**Count**	**6**
COMP 7270	# of Students	17	1	0	0	0
Zhou	% of Students	94.4%	5.6%	0.0%	0.0%	0.0%
			Score	**98.6**	**Count**	**18**
COMP 7300	# of Students	13	10	2	1	0
Baskiyar	% of Students	50.0%	38.5%	7.7%	3.8%	0.0%
			Score	**83.7**	**Count**	**26**
COMP 7370	# of Students	2	0	0	0	0
Shu	% of Students	100.0%	0.0%	0.0%	0.0%	0.0%
			Score	**100.0**	**Count**	**2**
COMP 7500	# of Students	13	4	0	0	0
Qin	% of Students	76.5%	23.5%	0.0%	0.0%	0.0%
			Score	**94.1**	**Count**	**17**
COMP 7620	# of Students	0	0	0	0	0

Seals	% of Students					
			Score	**0.0**	**Count**	**0**
COMP 7720	# of Students	1	1	0	0	0
Yamposkiy	% of Students	50.0%	50.0%	0.0%	0.0%	0.0%
			Score	**87.5**	**Count**	**2**
COMP 7970-NLP	# of Students	3	0	0	0	0
Karmaker	% of Students	100.0%	0.0%	0.0%	0.0%	0.0%
			Score	**100.0**	**Count**	**3**
COMP 8990	# of Students	45	13	4	0	0
Qualtrics Measure 1	% of Students	72.6%	21.0%	6.5%	0.0%	0.0%
			Score	**91.5**	**Count**	**62**
COMP 8990	# of Students	39	18	4	0	0
Qualtrics Measure 2	% of Students	63.9%	29.5%	6.6%	0.0%	0.0%
			Score	**89.3**	**Count**	**61**
COMP 8990	# of Students	30	28	4	0	0
Qualtrics Measure 3	% of Students	48.4%	45.2%	6.5%	0.0%	0.0%
			Score	**85.5**	**Count**	**62**
COMP 8990	# of Students	30	29	3	0	0
Qualtrics Measure 4	% of Students	48.4%	46.8%	4.8%	0.0%	0.0%
			Score	**85.9**	**Count**	**62**
COMP 8990	# of Students	33	28	1	0	0
Qualtrics Measure 5	% of Students	53.2%	45.2%	1.6%	0.0%	0.0%
			Score	**87.9**	**Count**	**62**
COMP 8990	# of Students	27	33	2	0	0
Qualtrics Measure 6	% of Students	43.5%	53.2%	3.2%	0.0%	0.0%
			Score	**85.1**	**Count**	**62**
COMP 8990	# of Students	27	31	4	0	0
Qualtrics Measure 7	% of Students	43.5%	50.0%	6.5%	0.0%	0.0%
			Score	**84.3**	**Count**	**62**
COMP 8990	# of Students	30	32	0	0	0
Qualtrics Measure 8	% of Students	48.4%	51.6%	0.0%	0.0%	0.0%
			Score	**87.1**	**Count**	**62**
COMP 8990	# of Students	29	29	4	0	0
Qualtrics Measure 9	% of Students	46.8%	46.8%	6.5%	0.0%	0.0%
			Score	**85.1**	**Count**	**62**

All the scores recorded in the following table are automatically derived from the curriculum map coupled with the above direct measurement data. The assessment data from the directed study and dissertation research were collected in the fall 2022 and spring 2023 semesters. The assessment data of dissertation research can be found in Section 8.2 on page 14. Each SLO metric is evaluated in a scale from 0 to 100,

where a score in [90, 100] is *Exemplary*, [80, 90] is *Proficient*, [70, 80] is *Needs Improvement*, and [0, 70] is *Unsatisfactory*. The following table summarizes the SLO results derived from the course-level data.

The SLO Results Derived from the Direct Measurement Data

	SLO 1	SLO 2	SLO 3	SLO 4	SLO 1	SLO 2	SLO 3	SLO 4	SLO 1	SLO 2	SLO 3	SLO 4
6000 Web Application Development		1.00		1.00		4.00		4.00		400.00		400.00
6120 Database Systems I (Fall/Spring)	1.00	1.00	0.33	0.66	5.00	5.00	1.65	3.30	500.00	500.00	165.00	330.00
6130 Data Mining	1.00	0.33	0.66	1.00	3.00	0.99	1.98	3.00	300.00	99.00	198.00	300.00
6210 Compiler Construction	0.66	1.00	0.33	0.66	0.66	1.00	0.33	0.66	66.00	100.00	33.00	66.00
6320 Design and Analysis of Computer Networks	0.66	0.66	1.00		3.30	3.30	5.00		297.00	297.00	450.00	0.00
6340 Network Quality Assurance and Simulation	0.33	0.66	1.00									
6350 Digital Forensics	0.33				0.00				0.00			
6360 Wireless and Mobile Networks	1.00	0.66	1.00	0.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6370 Computer and Network Security	0.33		1.00		0.00		0.00		0.00		0.00	
6400 Foundation of Computer Graphics		0.66	1.00									
6520 Network and Operating Sys Admin			1.00				0.00				0.00	
6530 Cloud Computing		1.00	0.33			0.00	0.00			0.00	0.00	
6600 Artificial Intelligence	0.66		1.00		0.00		0.00		0.00		0.00	
6620 User Interface Design and Evaluation		0.66	1.00	0.66		0.00	0.00	0.00		0.00	0.00	0.00
6630 Machine Learning	0.66	0.66	0.66	0.66	3.30	3.30	3.30	3.30	313.50	313.50	313.50	313.50
6660 Intro to Evolutionary Comp	0.66	0.66	1.00	0.66	1.98	1.98	3.00	1.98	181.50	181.50	275.00	181.50
6700 Software Process		1.00										
6710 Software Quality Assurance	0.66	1.00	0.66	1.00	0.66	1.00	0.66	1.00	16.50	25.00	16.50	25.00
6970 Special Topics: Comp Intel. & Adversarial ML	0.66	0.66	1.00	0.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6970 Special Topics: Game Design for Social Change	1.00	0.33	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6970 Special Topics: Cybersecurity Threats&CounterM	1.00	0.33	0.33		0.00	0.00	0.00		0.00	0.00	0.00	
6970 Special Topics: Cyber Physical Systems Security			0.66	0.66			1.98	1.98			198.00	198.00
6970 Special Topics: Computational Biology		0.66	1.00	1.00		0.66	1.00	1.00	0.00	66.00	100.00	100.00

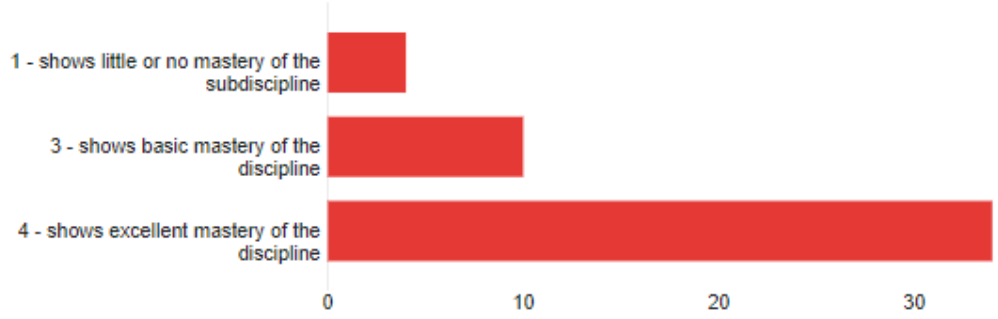
6970 Special Topics: Deep Learning	0.66	0.66	1.00	0.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6970 Special Topics: Game Design and Development	0.66	1.00	0.33		0.00	0.00	0.00		0.00	0.00	0.00	
6970 Special Topics: Information Retrieval		0.66	0.33	0.66		1.98	0.99	1.98		198.00	99.00	198.00
6830 Cybersecurity Threats and Countermeasures	1.00	0.66	1.00	0.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6970 Special Topics: Software Analytics		1.00	1.00	0.66		0.00	0.00	0.00				
6970 Special Topics: iOS Development	1.00	0.66	0.00	0.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6970 Special Topics: Binary Program Analysis	0.33	0.66	1.00	0.66	0.33	0.66	1.00	0.66	33.00	66.00	100.00	66.00
7120 Database Systems II			1.00	1.00								
7270 Advanced Topics in Algorithms	1.00	1.00	1.00	1.00	18.00	18.00	18.00	18.00	1775.00	1775.00	1775.00	1775.00
7300 Advanced Computer Architecture	1.00	0.66	1.00	0.33	26.00	17.16	26.00	8.58	2175.00	1435.50	2175.00	717.75
7330 Topics in Parallel and Distributed Computing		0.66	1.00	0.33								
7370 Advanced Computer and Network Security	1.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00	200.00	200.00	200.00	200.00
7500 Advanced Topics in Operating Systems	1.00	0.66	0.33	0.33	17.00	11.22	5.61	5.61	1600.00	1056.00	528.00	528.00
7620 Human Computer Interaction		0.33	1.00	0.33		0.00	0.00	0.00		0.00	0.00	0.00
7700 Software Architecture		1.00										
7720 Software Re-Engineering	0.83	0.00	0.00	0.66	1.66	0.00	0.00	1.32	145.25	0.00	0.00	115.50
7800 AI for Security			1.00				0.00				0.00	
7950 Introduction Graduate Study Computer Science				0.33								
7970 Natural Language Processing		0.66	0.66	1.00		1.98	1.98	3.00		198.00	198.00	300.00
8930 Directed Study	0.66	0.66	1.00	1.00	3.96	3.96	6.00	6.00	396.00	396.00	600.00	600.00
8990 Research and Thesis, Measure 1	0.66	0.00	0.00	0.00	10.23	0.00	0.00	0.00	936.38	0.00	0.00	0.00
8990 Research and Thesis, Measure 2	0.00	0.00	1.00	0.00	0.00	0.00	2.52	0.00	0.00	0.00	340.63	0.00
8990 Research and Thesis, Measure 3	0.00	0.00	1.00	0.00	0.00	0.00	2.56	0.00	0.00	0.00	331.25	0.00
8990 Research and Thesis, Measure 4	0.00	0.00	1.00	0.00	0.00	0.00	2.56	0.00	0.00	0.00	332.81	0.00
8990 Research and Thesis, Measure 5	0.00	0.00	0.00	1.00	0.00	0.00	0.00	2.56	0.00	0.00	0.00	340.63
8990 Research and Thesis, Measure 6	0.00	0.00	0.00	1.00	0.00	0.00	0.00	2.56	0.00	0.00	0.00	329.69
8990 Research and Thesis, Measure 7	0.00	0.00	1.00	0.00	0.00	0.00	2.56	0.00	0.00	0.00	326.56	0.00

8990 Research and Thesis, Measure 8	0.00	0.00	0.00	1.00	0.00	0.00	0.00	2.56	0.00	0.00	0.00	337.50
8990 Research and Thesis, Measure 9	0.00	0.00	0.00	1.00	0.00	0.00	0.00	2.56	0.00	0.00	0.00	329.69
Weights	20.75	24.86	32.61	25.55	98.39	74.23	89.92	76.97				
Scores									9021.50	6910.50	8155.25	7151.75
Final Scores									**92.0**	**93.4**	**91.3**	**93.5**
Ratings									**Exemplary**	**Exemplary**	**Exemplary**	**Exemplary**

Note: Please refer to a comparison table on page 39.

8.2 Assessment Results of Ph.D. General Oral Exams

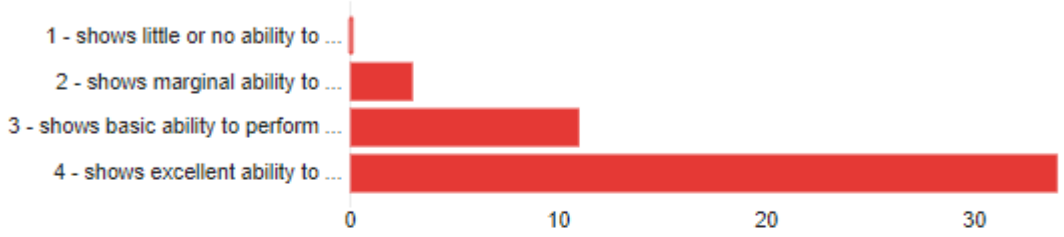
1 - Each doctoral candidate is expected to demonstrate mastery of the basic principles of at least one of the disciplines of CSSE. Please assess this candidate using the following scale



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Each doctoral candidate is expected to demonstrate mastery of the basic principles of at least one of the disciplines of CSSE. Please assess this candidate using the following scale	1.00	4.00	3.54	0.87	0.75	48

Field	Choice Count
1 - shows little or no mastery of the subdiscipline	4
3 - shows basic mastery of the discipline	10
4 - shows excellent mastery of the discipline	34
Total	48

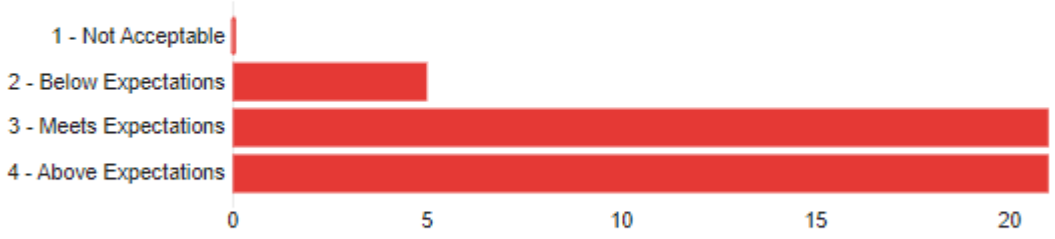
2 - Each doctoral candidate is expected to perform cutting-edge research in at least one area of specialty. Please assess this candidate using the following scale:



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Each doctoral candidate is expected to perform cutting-edge research in at least one area of specialty. Please assess this candidate using the following scale:	2	4	4	1	0	48

Field	Choice Count
1 - shows little or no ability to perform CSSE research	0
2 - shows marginal ability to perform CSSE research	3
3 - shows basic ability to perform CSSE research	11
4 - shows excellent ability to perform CSSE research	34
Total	48

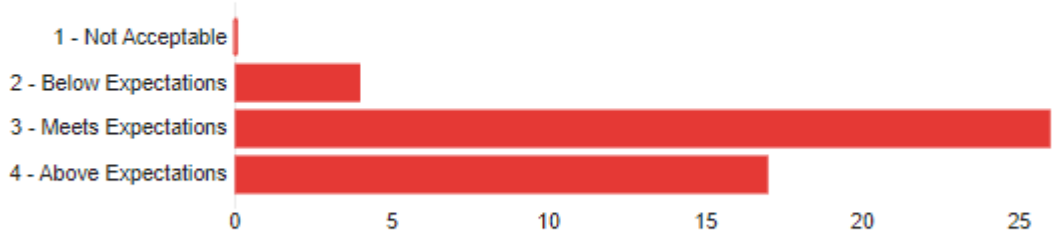
3 - Content: appropriate, complete, concise, and logically organized; problem, approach and results clear; appropriate use of time.



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Content: appropriate, complete, concise, and logically organized; problem, approach and results clear; appropriate use of time.	2	4	3	1	0	47

Field	Choice Count
1 - Not Acceptable	0
2 - Below Expectations	5
3 - Meets Expectations	21
4 - Above Expectations	21
Total	47

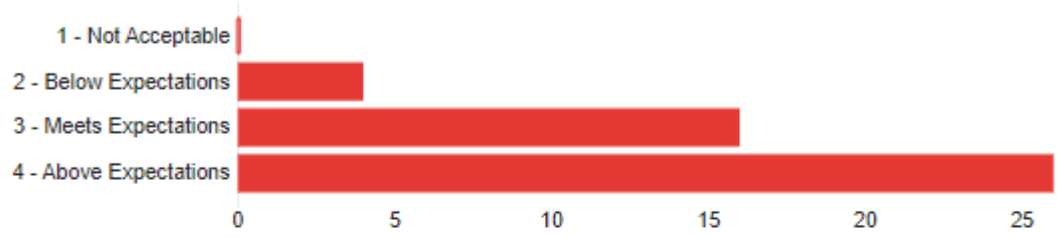
4 - Visual aids: readable & clear, concise wording, effective use of graphics, appropriate amount of information.



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Visual aids: readable & clear, concise wording, effective use of graphics, appropriate amount of information.	2	4	3	1	0	47

Field	Choice Count
1 - Not Acceptable	0
2 - Below Expectations	4
3 - Meets Expectations	26
4 - Above Expectations	17
Total	47

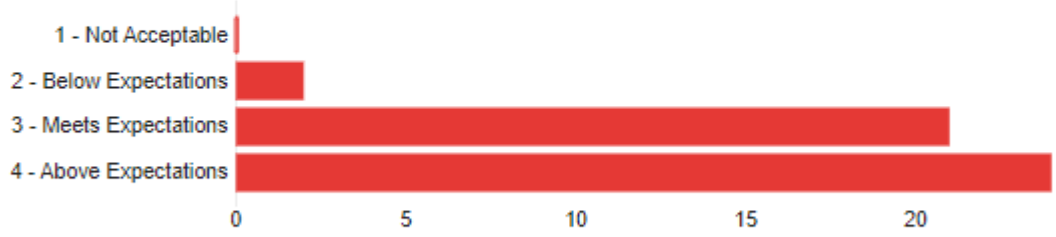
5 - Presenter: appears well-prepared, vocabulary technically correct and audience appropriate.



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Presenter: appears well-prepared, vocabulary technically correct and audience appropriate.	2	4	3	1	0	46

Field	Choice Count
1 - Not Acceptable	0
2 - Below Expectations	4
3 - Meets Expectations	16
4 - Above Expectations	26
Total	46

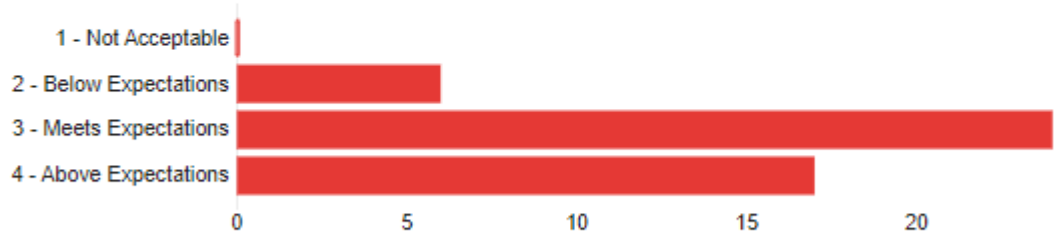
6 - Presentation mechanics: good voice volume, enunciation, speed; free of hesitations, distracting mannerisms; good poise, eye contact.



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Presentation mechanics: good voice volume, enunciation, speed; free of hesitations, distracting mannerisms; good poise, eye contact.	2	4	3	1	0	47

Field	Choice Count
1 - Not Acceptable	0
2 - Below Expectations	2
3 - Meets Expectations	21
4 - Above Expectations	24
Total	47

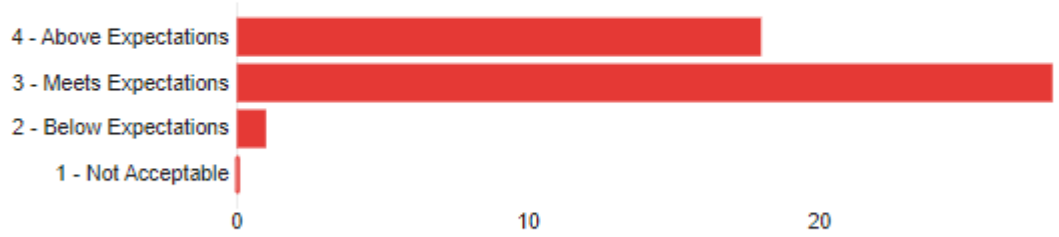
7 - Responses to questions and comments: appropriate, direct, and complete



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Responses to questions and comments: appropriate, direct, and complete	2	4	3	1	0	47

Field	Choice Count
1 - Not Acceptable	0
2 - Below Expectations	6
3 - Meets Expectations	24
4 - Above Expectations	17
Total	47

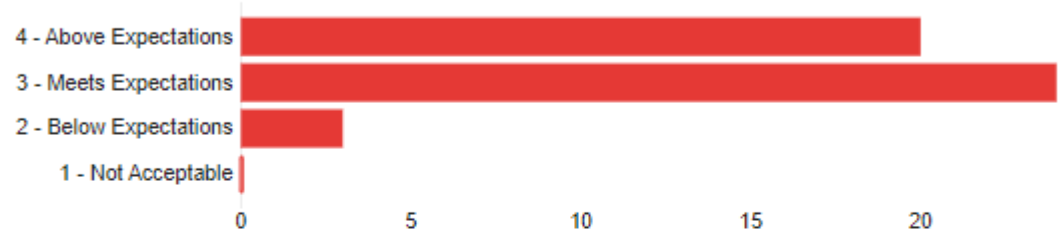
8 - Quality of English: good grammatical form, voice, tense, punctuation. Concise presentation



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Quality of English: good grammatical form, voice, tense, punctuation. Concise presentation	1	3	2	1	0	47

Field	Choice Count
4 - Above Expectations	18
3 - Meets Expectations	28
2 - Below Expectations	1
1 - Not Acceptable	0
Total	47

9 - Technical writing content: good organization; clear description of problem, state-of-the art, technical approach, and results; clear figures and tables; relevant and timely references

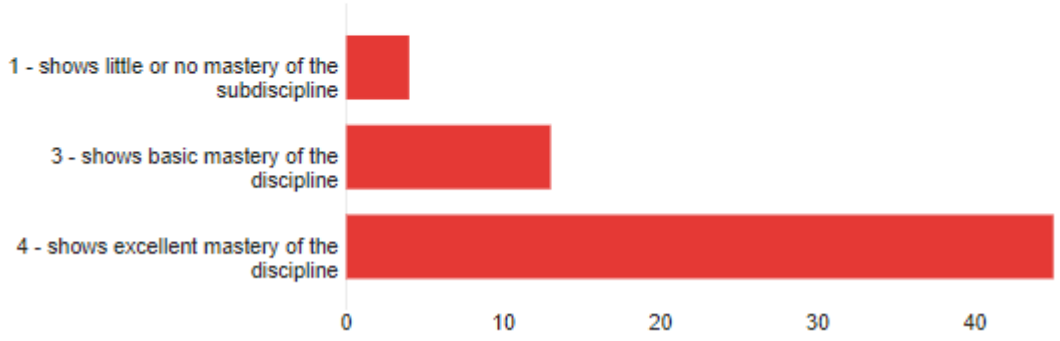


Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Technical writing content: good organization; clear description of problem, state-of-the art, technical approach, and results; clear figures and tables; relevant and timely references	1	3	2	1	0	47

Field	Choice Count
4 - Above Expectations	20
3 - Meets Expectations	24
2 - Below Expectations	3
1 - Not Acceptable	0
Total	47

8.3 Assessment Results of Ph.D. Final Oral Exams

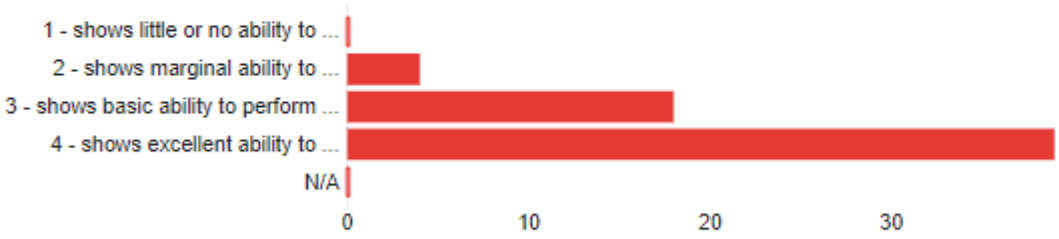
1 - Each doctoral candidate is expected to demonstrate mastery of the basic principles of at least one of the disciplines of CSSE. Please assess this candidate using the following scale



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Each doctoral candidate is expected to demonstrate mastery of the basic principles of at least one of the disciplines of CSSE. Please assess this candidate using the following scale	1.00	4.00	3.60	0.79	0.63	62

Field	Choice Count
1 - shows little or no mastery of the subdiscipline	4
3 - shows basic mastery of the discipline	13
4 - shows excellent mastery of the discipline	45
Total	62

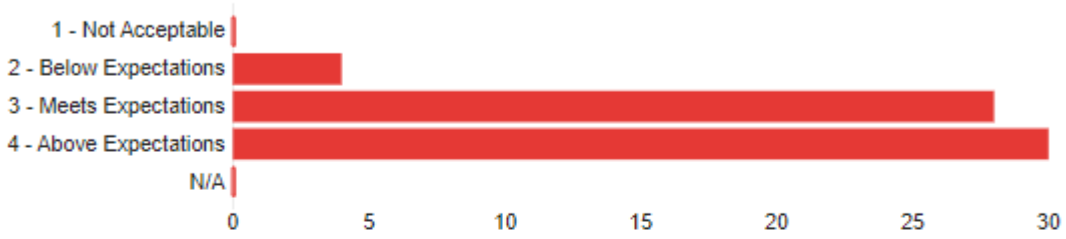
2 - Each doctoral candidate is expected to perform cutting-edge research in at least one area of specialty. Please assess this candidate using the following scale:



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Each doctoral candidate is expected to perform cutting-edge research in at least one area of specialty. Please assess this candidate using the following scale:	2	4	4	1	0	61

Field	Choice Count
1 - shows little or no ability to perform CSSE research	0
2 - shows marginal ability to perform CSSE research	4
3 - shows basic ability to perform CSSE research	18
4 - shows excellent ability to perform CSSE research	39
N/A	0
Total	61

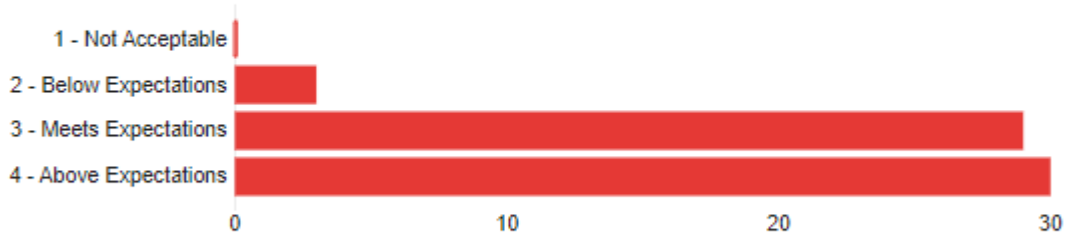
3 - Content: appropriate, complete, concise, and logically organized; problem, approach and results clear; appropriate use of time.



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Content: appropriate, complete, concise, and logically organized; problem, approach and results clear; appropriate use of time.	2	4	3	1	0	62

Field	Choice Count
1 - Not Acceptable	0
2 - Below Expectations	4
3 - Meets Expectations	28
4 - Above Expectations	30
N/A	0
Total	62

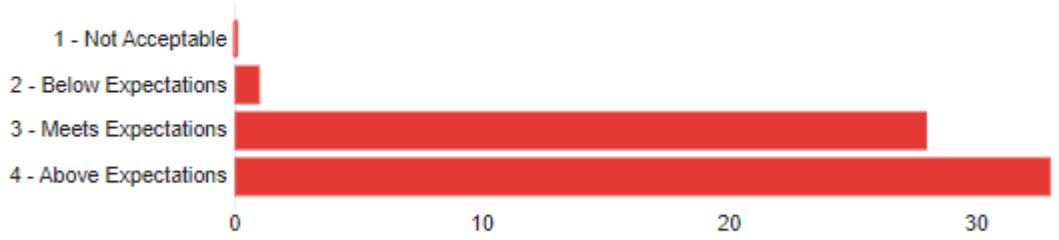
4 - Visual aids: readable & clear, concise wording, effective use of graphics, appropriate amount of information.



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Visual aids: readable & clear, concise wording, effective use of graphics, appropriate amount of information.	2	4	3	1	0	62

Field	Choice Count
1 - Not Acceptable	0
2 - Below Expectations	3
3 - Meets Expectations	29
4 - Above Expectations	30
Total	62

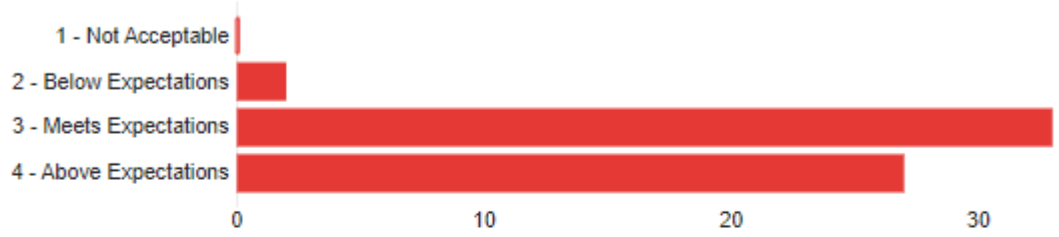
5 - Presenter: appears well-prepared, vocabulary technically correct and audience appropriate.



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Presenter: appears well-prepared, vocabulary technically correct and audience appropriate.	2	4	4	1	0	62

Field	Choice Count
1 - Not Acceptable	0
2 - Below Expectations	1
3 - Meets Expectations	28
4 - Above Expectations	33
Total	62

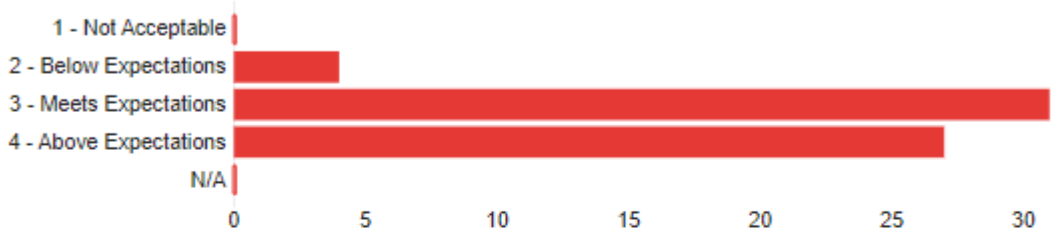
6 - Presentation mechanics: good voice volume, enunciation, speed; free of hesitations, distracting mannerisms; good poise, eye contact.



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Presentation mechanics: good voice volume, enunciation, speed; free of hesitations, distracting mannerisms; good poise, eye contact.	2	4	3	1	0	62

Field	Choice Count
1 - Not Acceptable	0
2 - Below Expectations	2
3 - Meets Expectations	33
4 - Above Expectations	27
Total	62

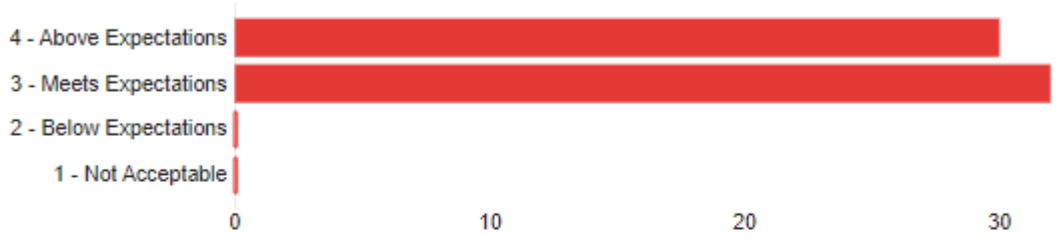
7 - Responses to questions and comments: appropriate, direct, and complete



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Responses to questions and comments: appropriate, direct, and complete	2	4	3	1	0	62

Field	Choice Count
1 - Not Acceptable	0
2 - Below Expectations	4
3 - Meets Expectations	31
4 - Above Expectations	27
N/A	0
Total	62

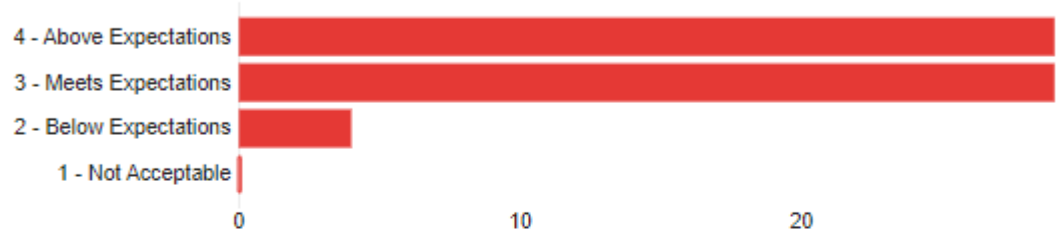
8 - Quality of English: good grammatical form, voice, tense, punctuation. Concise presentation



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Quality of English: good grammatical form, voice, tense, punctuation. Concise presentation	1	2	2	0	0	62

Field	Choice Count
4 - Above Expectations	30
3 - Meets Expectations	32
2 - Below Expectations	0
1 - Not Acceptable	0
Total	62

9 - Technical writing content: good organization; clear description of problem, state-of-the art, technical approach, and results; clear figures and tables; relevant and timely references



Field	Min	Max	Mean	Standard Deviation	Variance	Responses
Technical writing content: good organization; clear description of problem, state-of-the art, technical approach, and results; clear figures and tables; relevant and timely references	1.00	3.00	1.60	0.61	0.37	62

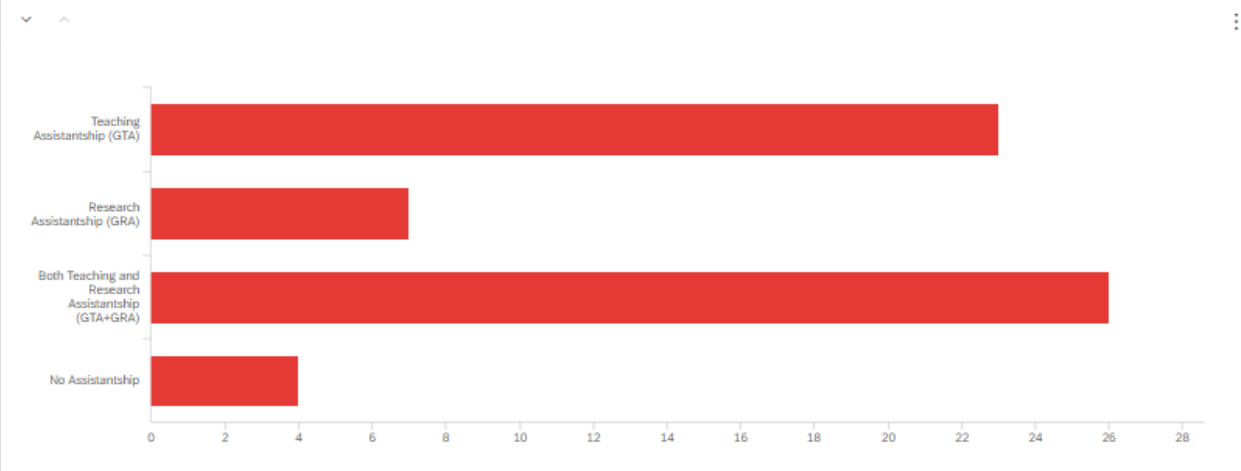
Field	Choice Count
4 - Above Expectations	29
3 - Meets Expectations	29
2 - Below Expectations	4
1 - Not Acceptable	0
Total	62

8.4 Indirect Measure Data: Ph.D. Student Annual Reports

Apart from direct measures, indirect measures collected from surveys will be used to assess the student learning outcomes.

Q1-5 - Have you awarded any assistantship in the past year?

Page Options



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Have you awarded any assistantship in the past year?	1.00	4.00	2.18	1.02	1.05	60

#	Field	Choice Count	
1	Teaching Assistantship (GTA)	38.33%	23
2	Research Assistantship (GRA)	11.67%	7
3	Both Teaching and Research Assistantship (GTA+GRA)	43.33%	26
4	No Assistantship	6.67%	4

Q2-2 - Have you passed your dissertation proposal defense (General Oral Exam)?

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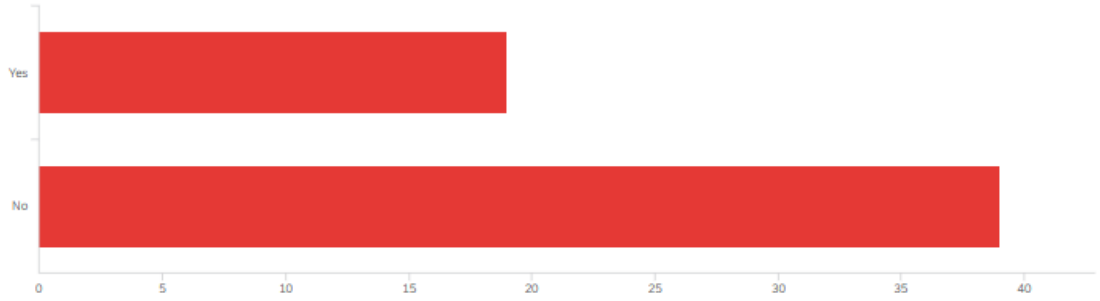


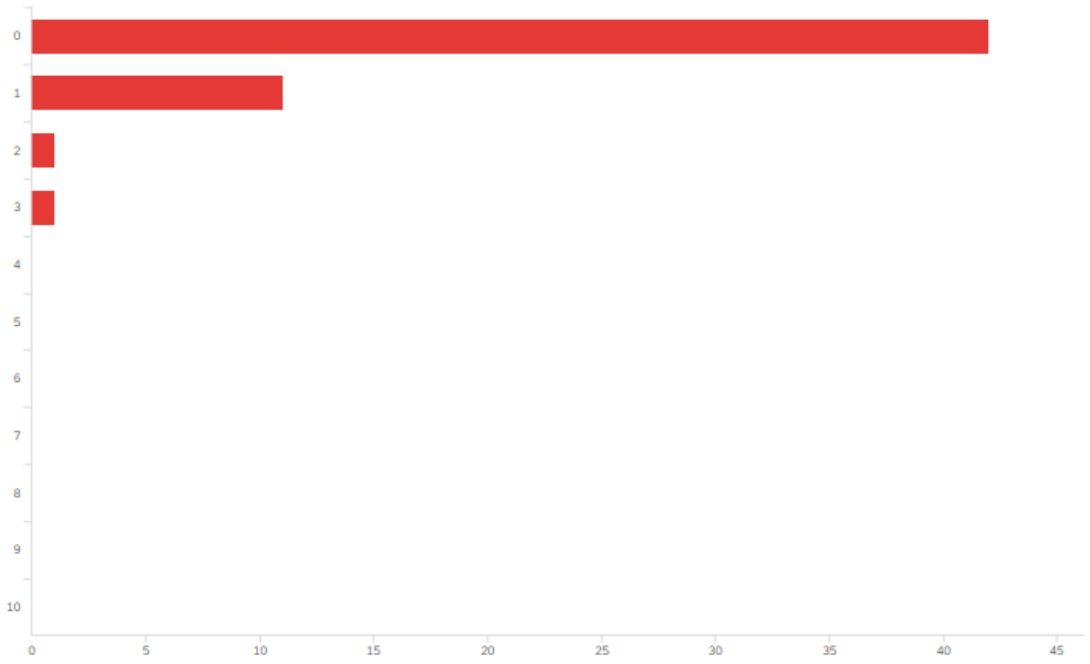
#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Have you passed your dissertation proposal defense (General Oral Exam)?	1.00	2.00	1.67	0.47	0.22	58

#	Field	Choice Count	
1	Yes	32.76%	19
2	No	67.24%	39
			58

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	How many journal papers have you published in the past year?	1.00	8.00	1.48	1.30	1.70	80

Q3-1 - How many journal papers have you published in the past year?

Page Options



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	How many journal papers have you published in the past year?	1.00	4.00	1.29	0.59	0.35	55

#	Field		Choice Count
1	0	76.36%	42
2	1	20.00%	11
3	2	1.82%	1
4	3	1.82%	1
5	4	0.00%	0
6	5	0.00%	0
7	6	0.00%	0
8	7	0.00%	0
9	8	0.00%	0
10	9	0.00%	0
11	10	0.00%	0
			55

Q3-2 - How many conference/workshop papers have you published in the past year?

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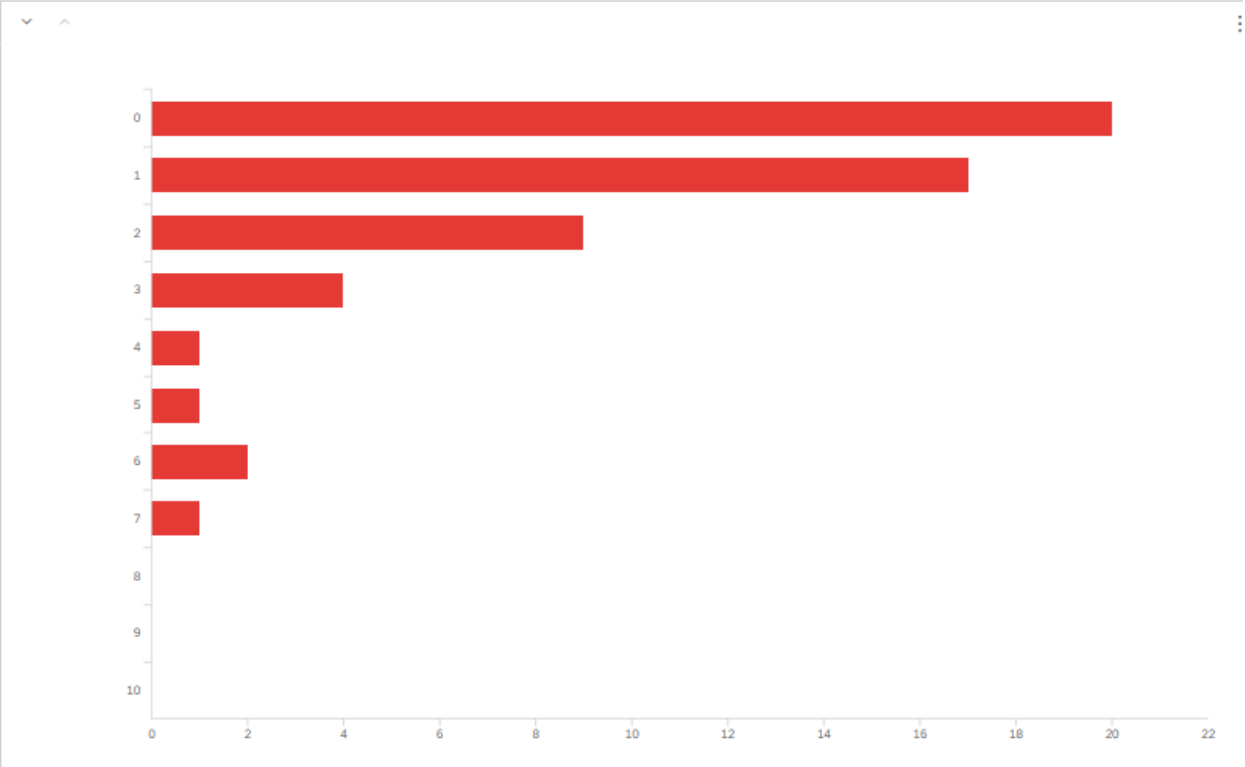


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	How many conference/workshop papers have you published in the past year?	1.00	8.00	2.36	1.64	2.70	55

#	Field		Choice Count
1	0	36.36%	20
2	1	30.91%	17
3	2	16.36%	9
4	3	7.27%	4
5	4	1.82%	1
6	5	1.82%	1
7	6	3.64%	2
8	7	1.82%	1
9	8	0.00%	0
10	9	0.00%	0
11	10	0.00%	0
			55

8.5 Indirect Measurement Data: Ph.D. and GTA Annual Evaluation

The CSSE graduate faculty members also evaluated the annual performance of the Ph.D. students and graduate teaching assistants (GTAs). The following evaluation reports were submitted to the Graduate School last year in October.

Annual Review of GTA and Ph.D. Students: 2021-2022

	Satisfactory	Satisfactory Rate	Unsatisfactory	Unsatisfactory Rate	Total
PhD Students	131	94.9%	7	5.1%	138
GTAs	76	96.2%	3	4%	79
Overall	207	95.4%	10	4.6%	217

Annual Review of Ph.D. Students: Comparison with Previous Years

	Satisfactory	Satisfactory Rate	Unsatisfactory	Unsatisfactory Rate	Total
2021-2022 PhD Students	131	94.9%	7	5.1%	138
2020-2021 PhD Students	119	93.7%	8	6.3%	127

Annual Review of GTA Students: Comparison with Previous Years

	Satisfactory	Satisfactory Rate	Unsatisfactory	Unsatisfactory Rate	Total
2021-2022 GTAs	76	96.2%	3	3.8%	79
2020-2021 GTAs	66	97.1%	2	2.9%	68

Overall, we have submitted a total of 217 annual review reports, among which 7 PhD students and 3 GTAs received unsatisfactory ratings. The satisfactory rates of Ph.D. and GTA students are 94.9% and 96.2%, respectively. Ph.D. satisfactory rate increased from 93.7% to 94.9% compared to the same period a year ago, but the GTA satisfactory rate dropped from 97.1% to 96.2% compared to the 2020-2021 data.

9. Interpreting Results

The aggregate data are summarized in the following table. The detailed assessment data can be found in TABLE - The SLO Results Derived from the Direct Measurement Data on pages 14 and 15 in Section 8.1. The key takeaways from the assessment data are:

- The ratings of all the four SLOs 1 are "Exemplary".
- The 2022-2023 student performance ratings are lower than those of the 2019-2020, 2020-2021, and 2021-2022 periods. This drop is mainly due to the new assessment data incorporated in this assessment cycle.
- In the 2021-2022 cycle, the doctoral students achieved slightly better software development skills than the other measured skills. This year, however, the student research-skill measure - SLO 3 - turns out to be the lowest among its peers.

9.1 Results of the Direct Measurements

The results coupled with the comparison with the last assessment cycle can be found in the table listed below. Our target scores for all four student learning outcomes (SLOs) are 90 or above. The final scores for the four SLOs in the year 2022-2023 are 92.0, 93.4, 91.3, and 93.5, respectively. The ratings of all the four SLOs are as high as "Exemplary", but the SLO 3 score is the lowest among its peers. Furthermore, SLO 1, SLO 2, and SLO 4 are close to each other in the range between 92 and 94. Overall, all the four SLO measures meet our expectations.

Direct Measurement Data Comparison between the current cycle (2022-2023) and the previous cycles (2019-2022)

Ph.D. Program – Direct Measures	SLO 1	SLO 2	SLO 3	SLO 4
2022-2023 Final Scores	92.0	93.4	91.3	93.5
Ratings	Exemplary	Exemplary	Exemplary	Exemplary
2021-2022 Final Scores	94.2	95.1	96.1	95.9
Ratings	Exemplary	Exemplary	Exemplary	Exemplary
2020-2021 Final Scores	94.0	94.0	92.9	94.2
Ratings	Exemplary	Exemplary	Exemplary	Exemplary
2019-2020 Final Scores	91.4	93.5	91.9	92.5
Ratings	Exemplary	Exemplary	Exemplary	Exemplary

In the last three assessment cycles (2019-2020, 2020-2021, and 2021-2022), the four SLO scores are (91.4, 93.5, 91.9, 92.5), (94.0, 94.0, 92.9, 94.2), and (94.2, 95.1, 96.1, 95.9) respectively. SLO 1-4 measurement results are consistently lower than its counter parts in the previous three cycles because during this assessment period, we incorporate the general oral exam and final oral exam assessment data into the final analysis. The general oral exams (i.e., dissertation proposal defense) and the final oral exams (i.e., final defense) play a cardinal role in direct measurement data. It is unfair to compare the measures with previous cycles that did not include direct measures from the general oral and final oral exams. We plan to continue collecting the SLO outcome data in the next few years to make future comparisons fair.

9.2 Results of General Oral and Final Oral Examinations

Sections 9.2 and 9.3 present the results of indirect measures: Section 9.2 is focused on the results of the Ph.D. general oral examinations (proposal defense) and final oral examinations (dissertation defense). We study the publication records of the Ph.D. students in Section 9.3.

Comparison between the current cycle (2022-2023) and the previous years General Oral Exams

Ph.D. Program – General Oral Exams	Pass	Not Yet	Total	Passing Rate
2019 - 2020	8	68	76	10.5%
2020 - 2021	14	63	77	18.2%
2021-2022	23	58	81	28.4%
2022-2023	19	39	58	**32.8%**

During the past three assessment cycles, the passing rates were 10.5%, 18.2%, and 28.4% (see the Table at the bottom on page 35). These students tend to graduate within three semesters after their dissertation proposal defenses. In year 2022-2023, the passing rate of students passing the general oral exams jumps to 32.8%. The Ph.D. program exhibits a stunning growth in terms of general oral exam passing rate, which significantly climbs by 15.4%. The graduate faculty aims to maintain the general exam passing rate at the target level of 25% in the next three years, and we met this benchmark target this year.

While the data shown in the above table are the number of students who passed the general oral exams in the past few years, the following table registers the number of Ph.D. student who took and pass the general oral exam in the current assessment period (2022-2023). We are pleased to report that the number of students who recently passed their dissertation proposal defense leaps to 24 – an immense improvement of over 118% over the data gleaned in the 2021-2022 cycle. We expect this number slightly drop next year due to the shrinking enrollment.

The Number of Ph.D. Students Passed General Oral Exams

12-19	19-20	20-21	21-22	22-23	23-24	24-25
N/A	7	11	**24**	-	-	-

In what follows, we unveil the number of Ph.D. awarded in the past 10 years. Before the 2020-2021 assessment period, the number of annual Ph.D. awarded is hovering around 4 to 8 with an exception of 13 made in 2014-2015. Not surprisingly, the annual Ph.D. productivity is maintained at a high level of 21, which matches the last cycle's productivity of 20 – a staggering enhancement over the past two years. We are hopeful that the faculty and graduate students will keep up with the landmark achievement in the future assessment periods.

The Number of Ph.D. Degree Awarded

12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-22
9	7	13	8	8	6	4	6	6	20
22-23	23-24	24-25	25-26	26-27	27-28	28-29	29-30	30-31	31-32
22	-	-	-	-	-	-	-	-	-

9.3 Conference and Journal Publications

Now we investigate our Ph.D. students' research productivity in terms of the number of journal and conference papers published in the current assessment cycle.

Comparison between the current cycle (2022-2023) and the previous years

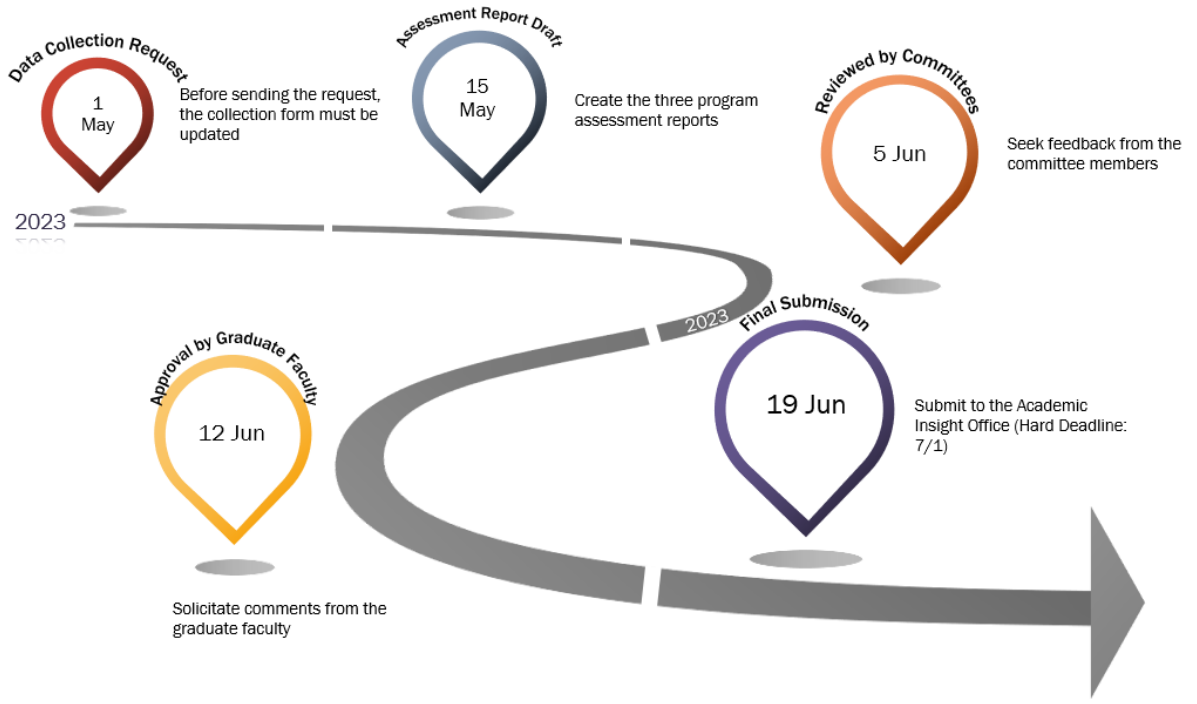
Publication Productivity

Ph.D. Student Research Productivity	Number of Responses	Journal Papers Total	Journal Papers Average	Conference Papers Total	Conference Papers Average	All Total	All Avg
2019 - 2020	76	95	1.25	137	1.80	232	3.05
2020 - 2021	74	122	1.65	116	1.59	238	3.22
2021 - 2022	80	118	1.48	160	2	278	3.48
2022 - 2023	55	71	1.29	130	2.36	201	3.65
-	-	-	-	-	-	-	-

The above table highlights the doctoral students' research productivity in terms of the numbers of journal and conference publications. In the last three cycles (2019-2020, 2020-2021, 2021-2022), the average number of journal publications is 1.25, 1.65, and 1.48, whereas the average number of journal papers slightly drops to 1.29 in the current assessment cycle. The good news is that the average number of conference papers continue surging from 2.0 to 2.36, an improvement of 18%. We are proudly report that our doctoral students' overall publication productivity continues growing from 3.48 to 3.65, representing an improvement of 5.7%. Our goal is to ensure that student publication productivity will be maintained at the impressive level of 3.0: this year we meet the benchmark target in terms of research productivity.

10. Communicating Results

The program outcomes were shared with the CSSE faculty through an email announcement. The program outcomes have been posted on the CSSE graduate programs website in September 2020 after the 2019-2020 report was submitted. This latest annual assessment report was shared with the CSSE faculty members through the graduate faculty mailing list on Thursday, June 15, 2023 in the summer 2023 semester. After we incorporated the faculty's comments on this report, the assessment report is submitted to the Office of Academic Assessment. In additional, the assessment report was submitted to Dr. Fergus and Dr. Auad, the Associate Deans who oversee program assessment and graduate studies in the Samuel Ginn College of Engineering. The final version of this assessment report will be shared, distributed, and discussed during a faculty meeting scheduled in the first week of the fall 2023 semester.



The above infographic sketches the timeline of the entire assessment procedure, including data collection, data analysis, assessment report writing, graduate programs committee review, CSSE graduate faculty approval, and final report submission. The procedure starts at the beginning of May, and the annual assessment report is submitted in the third week of June. The detailed milestones, deadlines, and description of each activity are tabulated in the table below.

CSSE Annual Graduate Program Assessment Timeline

PhD in Computer Science and Software Engineering

Day Month

Date	Milestone Title	Deadline	Description or Activity
5/1/2023	Data Collection Request	5/15/2023	Before sending the request, the collection form must be updated
5/15/2023	Assessment Report Draft	6/5/2023	Create the three program assessment reports
6/5/2023	Reviewed by Committees	6/12/2023	Seek feedback from the committee members
6/12/2023	Approval by Graduate Faculty	6/19/2023	Solicitate comments from the graduate faculty
6/19/2023	Final Submission		Submit to the Academic Insight Office (Hard Deadline: 7/1)

A vast majority of the CSSE graduate faculty members participated in the assessment procedure such as data collection. The graduate programs committee thoroughly reviewed this report before the CSSE graduate faculty approved the assessment report. To facilitate efficient communication, we provide the graduate faculty with a summary of the key findings from the report.

Use of Results

11. Purposeful Reflection

11.1 A Consistent and Ongoing Process

The graduate programs committee consists of five professors: Dr. Biaz, Dr. Ku, Dr. Baskiyar, Dr. Kandah, and Dr. Qin, who are committee to arrange a minimum of three meetings per year to evaluate and improve the Ph.D. program. Please note that Dr. Umphress retired last year, and Dr. Kandah – the chair of the Cybersecurity curriculum committee in the CSSE Department – is a new member serving on the CSSE graduate programs committee. The recommendations made by the graduate programs committee will be further reviewed by the CSSE graduate faculty in the first faculty meeting scheduled in the fall 2023 semester. In some cases, departmental policies will be forged to streamline the management of the Ph.D. program and doctoral students. The graduate faculty always offers insightful feedback to the graduate programs committee to brush up on proposed policies and strategies. In case of disagreements occur among graduate faculty members, the department chair – Dr. Narayanan – will collaborate with Dr. Hendrix, associate chair of the department, to spearhead a resolution through tradeoffs for the disagreements.

11.2 Implementation of the Above Process

In the spring 2023, the graduate programs committee had three meetings and the CSSE graduate faculty had one group meeting to discuss the updated Ph.D. course requirements and Ph.D. qualifying exam policy. The revised qualifying exam has been implemented for one year without a hitch, and the new Ph.D. curriculum model was approved by the CSSE faculty, Samuel Ginnn College of Engineering, and Auburn University. The new Ph.D. program was published in the NextBulletin site, which will be pushed to the official bulletin site at the end of the summer 2013 semester. The revised Ph.D. course requirements, coupled with the new Ph.D. qualifying exam policy, are slated to considerably bolster students' research productivity – student publication records are expected to climb in the next 5 to 10 years.

12. Action Plan

12.1 Observations

As the action item proposed last year, the raw data from COMP 8990 Dissertation Research were collected for the first time. We have quantitatively evaluated doctoral students' research performance through graduate faculty surveys when the students take the general oral exam (dissertation proposal defense) and/or final oral exam (final dissertation defense). The downside of this year's new assessment approach is that the comparison between the current cycle and the past cycles is a little bit unfair. Again, we still didn't glean the data from COMP 8930 Directed Studies for a two-fold reason. First, COMP 8930 is offered by individual members; collecting such data implies that the shared Google spreadsheet will have an excessive number of COMP 8930 rows. We purposely maintain a short spreadsheet.

In the 2022-2023 assessment cycle, the SLO 3 measure is the lowest among its peers. The CSSE graduate faculty aimed to improve the student performance in terms of SLO 3 in the 2022-2023 semesters. We will be focusing on the SLO 3 score during the next assessment cycle. Nevertheless, the final results demonstrate that the CSSE graduate faculty has fostered Ph.D. students' knowledge in algorithms, operating systems, and architecture, and the faculty also offer unique opportunities to boost the software development skills of the CSSE graduate students in summer 2022, fall 2022, and spring 2023 semesters.

Overall, the Ph.D. program in Computer Science and Software Engineering is strong; the graduate faculty will continue improving both the curriculum as well as the opportunities for extracurricular activities. We look forward to future faculty development accompanied by the constructive and insightful feedback offered by the Office of Academic Insight on our graduate program assessment report.

12.2 Future Actions

Action 1. Next year, we will aim to enhance the student performance in terms of SLO3 – "students will perform cutting-edge research in at least one area of specialty". We expect that the SLO3 score will be improved from 89.4 to 90.0, which is an exemplary level.

Action 2. The graduate programs committee will work closely with Dr. Ku – the instructor for COMP 6120 Database I – to pilot new approaches to strengthening the programming skills of master's students. Likewise, Dr. Qin, who regularly offers COMP 7500 Advanced Operating Systems, will take the following proposed strategies to cultivate the software development skills of master's students. We proposed the following ideas to bolster the student programming and software design skillsets.

- Offer multiple difficulty levels for programming projects.
- Allow students to pick their preferred programming languages.
- Assist students to find group members to develop collaborative course projects.
- Partner with the college's mentoring program to assign a mentor to COMP 6120 students.

Action 3. Recall that for the first time, we incorporated the assessment data from COMP 8990 Dissertation Research, but COMP 8930 assessment data were excluded in the aggregated SLO results presented on page 15. During the next assessment period, COMP 8930 data will be seamlessly incorporated into the SLO measures.

Action 4. Recall that the CSSE doctoral students' research productivity in terms of both conference and journal publications is 3.65, which jumps by 4.9% compared with last year's student research productivity. To ensure that the publication productivity is maintained at a high level of 3.5, the CSSE graduate faculty will supervise the Ph.D. students to have preliminary results published in conference proceedings followed by extended versions submitted to journals. We believe that another strategy to push up research productivity is encouraging students to collaborate with one another on their research projects, thereby strengthening publication records.

Action 5. Some Ph.D. students, including those who are being supported through graduate teaching assistantships, didn't make acceptable achievements with respect to publishing research papers. To address this concern, we will remind the students holding teaching assistantships that the maximum department support will be four years – the students are expected to publish at least two research papers per year to be on par with the other Ph.D. students in the department.

Action 6. We will pay attention to SLO1 – "SLO 1: Students will demonstrate mastery with in-depth knowledge in algorithms, operating systems, and architecture." The following three courses will contribute to the improvements of SLO1 measures. The graduate programs committee will arrange meetings with Drs. Zhou, Baskiyar, and Qin to propose a diversity of approaches to bolstering student performance in these three required courses.

- COMP 7270 Advanced Topics in Algorithms
- COMP 7300 Advanced Computer Architecture
- COMP 7500 Advanced Operating Systems

Action 7. In this assessment cycle, the data are manually collected by CSSE faculty members. It takes approximately a neighborhood of 20 to 30 minutes to harvest data for a course with an enrollment of 45. We opt to take this approach thanks to its simplicity. As an action item, we will pilot a way to make use of Canvas to align course components - assignments, quizzes, projects - to the graduate program SLOs – the direct measures will be automatically handled by Canvas to improve data collection efficiency.

It is practical to take full advantage of the Canvas system to automatically gauge assessment data. With regard to data collection, we have initiated a collaboration with Dr. Dorothy Thompson at the Academic Assessment Office to pilot an automatic way of gleaning data from the Canvas system. We had a kickoff meeting with Dr. Thompson on June 15. A second meeting with Dr. Thompson is scheduled in the first two weeks of the Fall'22 semester. A challenge to be addressed in the pilot study is how to deal with a common case where students from two or more graduate programs are taking the same graduate course managed by Canvas. This challenge is non-trivial because Canvas has no information about students' graduate programs. We will collaborate with Mr. Paul Springfield – the Canvas system administrator – to dig out a solution that streamlines the data collection process with automation.