Institutional Effectiveness Report
2019-20

Program: Computer Science BS

College and Department: College of Engineering – Computer Science

Contact: Jerry Gannod

Mission: "Our mission is to be widely recognized for enabling students to have global impact through innovative and quality programs, through research that emphasizes collaborative partnerships, and by enabling the success of a diverse student, faculty, and alumni community."

This mission is consistent with the University's mission to "provide leadership and outstanding programs in engineering, the sciences, and related areas that benefit the people of Tennessee and the nation" and with the University's commitment to the life-long success of students and to enrich the lives of people and communities in the Upper Cumberland region of Tennessee.

It is also consistent with Flight Plan, the University's strategic plan, and it's focus on improving student experience, transforming technology, and creating distinctive programs.

Program Goals:

1. *Professionalism:* Our graduates will exhibit the clear communication, responsible teamwork, commitment to quality, personal self-organization, professional attitude, and ethics needed to engage in successful careers in industry, academia, and public service.

2. *Leadership:* Our graduates will exhibit technical, personal, ethical, and professional leadership in their businesses, professions, and communities

3. *Technical Proficiency*: Our graduates will exhibit the technical proficiency and problem-solving skills required to positively impact organizations, people, and processes at the local and global levels

4. *Life-long Learning:* Our graduates will exhibit an ability to be self-motivated, life-long learners who adapt to new technologies, tools, and methodologies to maintain the ability to respond to the challenges of a changing environment.

Student Learning Outcomes

1. Analyze a complex computing problem and apply principles of computing and other relevant disciplines to identify solutions.

2. Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline.

3. Communicate effectively in a variety of professional contexts.

4. Recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.

5. Function effectively as a member or leader of a team engaged in activities appropriate to the program's discipline.

6. Apply computer science theory and software development fundamentals to produce computing-based solutions.

A departmentally developed curriculum map can be found in Appendix 1 that shows the connections between courses and student learning outcomes.

Assessment Methods

1. *Faculty Course Reflections (all courses**):*** Each faculty member is asked to complete a course reflection at the end of each semester. The reflection allows a faculty member to summarize the results of the course, map the appropriate objectives and outcomes to the course and identify successes from the semesters, opportunities for improvement, puzzles (i.e., questions to be resolved), suggested changes, issues with facilities, technology issues, and other reflections.

2. *Yearly Faculty/Staff Retrospective (program/department level):* At the beginning of each academic year the faculty engage in a retrospective covering the previous year. These retrospectives include identification of successes, opportunities for improvement, questions people have that need resolving, and creation of action items for improvement.

3. *Direct Assessment of Student Work (direct)**:*** Several courses are assessed every semester. These assessments directly examine student work based on traits (performance criteria) created specifically for each student outcome. The measurement rubric used for direct assessment uses a four-level rubric: Excelling, Practicing, Apprentice, and Novice (E/P/A/N).

4. *Pre-Post Surveys (Pre-Post)**:*** Pre-post surveys are conducted for courses in which a direct assessment is scheduled. The pre-post survey is administered twice: once at the beginning of a semester and again at the end of a semester.

5. *Senior Student Exit Surveys (Exit):* We have developed our own internally specified student exit survey conducted each semester and administered to graduating seniors. Several questions are asked that are related to specific course outcomes. This indirect assessment is conducted as a supplement to the direct assessments that examine student work. In this case, the students self-assess their perception of learning.

6. *Major Field Test (MFT):* Nationally-normed ETS Exam (global assessment) – We have administered the ETS Computer Science exam for several years as a supplemental data point for the program by mapping the three parts of the exam to two specific student outcomes

    a. Outcome 1: Analyze a complex computing problem and apply principles of computing and other relevant disciplines to identify solutions,

    b. Outcome 6: Apply computer science theory and software development fundamentals to produce computing-based solutions

7. *California Critical Thinking Skills Test (CCTST**)***: The CCTST is a nationally normed test that measures problem solving and decision making through formation of reasoned judgements. We use the CCTST

as a supplement to the direct and indirect assessments we conduct for Student Outcome 1: Analyze a complex computing problem and apply principles of computing and other relevant disciplines to identify solutions.

8. *External Advisory Board Review:* We conduct a review of Program Educational Objectives on a two-year cycle. These reviews allow us to determine whether the results are consistent with the expectations of these industrial stakeholders.

Assessment Tools, Frequency of Measurement, Applicability, and Attainment

Assessment Tool	Frequency	Applicability	Attainment Expectation
Course Reflections	Semester	General	N/A
Retrospectives	Yearly	General	N/A
Direct Assessments of Student Work	Semester	1 – 6	Summative: 70% in E/P Formative: 70% in E/P/A
Pre-Post Surveys	Semester	1 – 6	Shift in mean
Senior Exit Surveys	Semester	1 – 6	70%
Major Field Test	Semester	1 and 6 only	70th percentile
CA Critical Thinking Test	Semester	1	19 or higher
Board Review	Yearly and Mid-cycle	PEOs	N/A

Results:

Student Outcome 1: Analyze a complex computing problem and apply principles of computing and other relevant disciplines to identify solutions.

Outcome 1 is directly assessed along two specific traits (e.g., performance criteria):

- Students can identify and define the computing requirements appropriate to its solution
- Students can analyze and weigh trade-offs related to computing problems

In Course Direct Assessment Details

We use the general rule of thumb of attainment of 70% of students falling in the Excelling and Practicing levels of achievement as a marker for identifying potential action items for strategic and tactical changes to the curriculum.

Semester	Course	Trait	E	P	A	N	E/P	E/P/A	Action
Fa 2019	1300	1	72	13	14	1	85	99	None
			61	36	3	0	97	100	None
			68	21	7	4	89	96	None
		2	49	6	6	39	55	61	Flag
			67	21	13	0	88	100	None
			53	29	13	6	82	95	None
	4610	1	76	16	6	3	92	98	None
			20	3	49	29	23	72	Flag
			60	7	26	7	67	93	Observe
		2	27	3	48	23	30	78	Flag
			60	6	3	31	66	69	Observe
Sp 2019	1310	1	85	3	1	12	88	89	None
			20	27	35	19	47	81	Flag
			64	1	1	35	65	66	Observe
		2	19	38	18	27	56	74	Flag
			54	28	7	13	81	88	None
			36	20	17	29	55	72	Flag
Fa 2018	4610	1	71	21	5	4	92	97	None
			42	27	19	12	69	88	Observe
			87	13	0	0	100	100	None
		2	81	19	0	0	100	100	None
			78	21	0	1	99	99	None

In general, based on the direct assessments that were performed, students met the levels of attainment that were expected. However, Fall 2019 data from CSC 4610 identified potential changes as levels of

attainment fell below our 70% threshold for both Trait1 and Trait 2. Our discussions on these skills have led to identifying a need to focus on both the mindset and mechanics of requirements definitions through user stories so that the focus is not just on the rote practices, but also their usage in practice. The teaching team recommends creation of transferable knowledge from the Fall 2018 instructor and the Fall 2019 instructors, and development of more in-depth learning materials on the use of user stories. In particular, the instructors state that we "need to provide more examples and exercises for writing good user stories. We know from past experiences that the students get better at this in the following semester (as they continue to work on their project), but we need to think about getting them more experiences earlier."

The Major Field Test sub scores for two areas are used as a direct assessment of performance. We use the general rule of thumb of the 70th percentile for the program. For Outcome 1 we look to two-year windows for two sub scores:

- Operating Systems, Architecture, Networks, and Database
- Mathematics and Algorithms

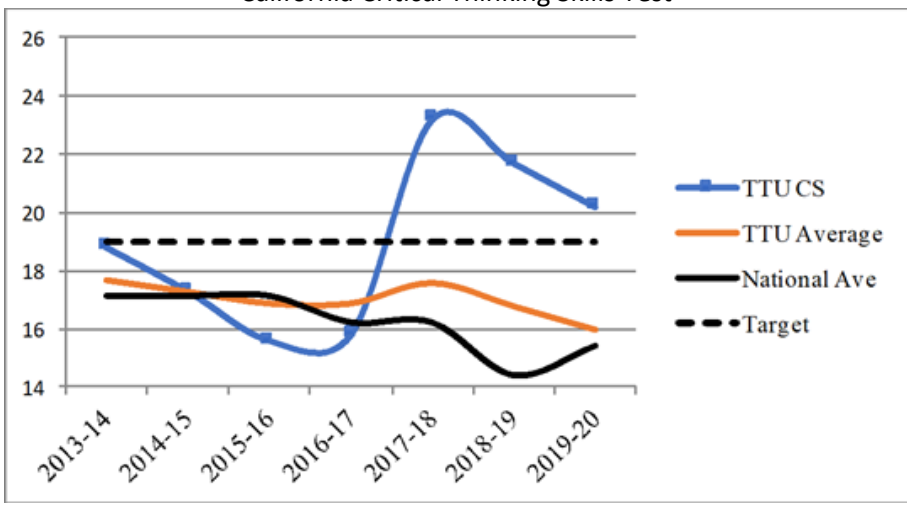
For several of the measurement windows from the Major Field Test, our students have achieved scores well above the 70th percentile attainment level. However, there is a drop-off on achievement of the attainment level in the F18 – S20 windows. We attribute this to issues arising from the Spring 2020 (pandemic era) tests as well as a change in administration of the test that began in Fall 2019. In Fall 2019, we observed a significant change in the administration of the test. A requirement mandating that the test be made a requirement for graduation was previously not enforced by the department. The enforcement of this requirement was met with a significant backlash from students. Furthermore, in Spring 2020, the administration of the test by ETS was severely degraded due to the use of online testing requiring third-party administration. For instance, many students were unable to take the test due to ETS-provided proctors not attending scheduled appointments.

Major Field Test

	Cohorts				
Category	F14 - S16	F15 - S17	F16 - S18	F17 - S19	F18 - S20*
OS, Arch, Nets, DB	80	90.2	96.1	90.9	57.4
Math, Alg	87.1	90.2	90.6	94.3	55.5
Overall	82.9	89.4	93.2	93	56.5
Satisfactory	70	70	70	70	70

In the periods of measurement for this test, our students have experienced a sharp upturn, averaging 23.2, 21.7, and 20.3 in 2017-18, 2018-19, and 2019- 20, respectively. Insight Assessment, the company responsible for the CCTST, state that a score of 19 is considered 'strong.' Thus, our goal is a score of 19. Note that we do not currently have the ability to differentiate this data by concentration, so we will be continuing to monitor this measure.

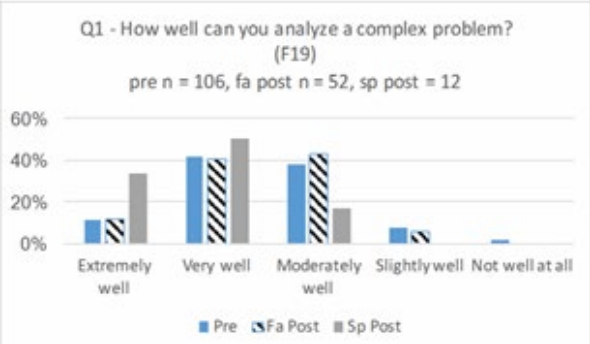
California Critical Thinking Skills Test

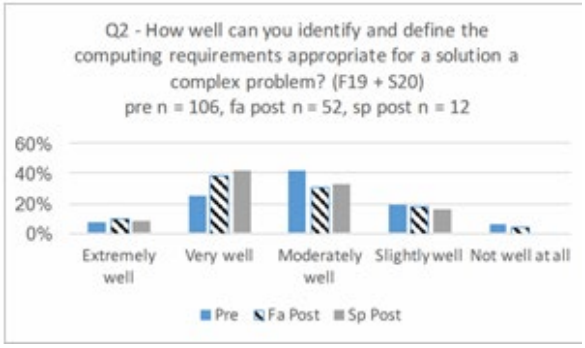


Indirect Assessments

We conduct pre-post surveys in courses in which we directly assess student work to determine student perceptions of learning. In general, we are interested in the mean changes in a given semester (or in the case of Question 2 for this year - changes across semesters). The charts below indicate a statistically significant change in the means as measured using the Student's T-Test. While the charts shown here are aggregated, the statistical analysis is disaggregated by course and in every case shows a "positive" increase in the means indicating that students perceive an increase in knowledge.

Pre-post Survey





The senior exit surveys, conducted when students complete the program, ask three identical questions to the pre-post surveys. The results of the surveys are below with the percentage of students responding either "Excellent" or "Good".

In general, this points to students' perception that they have gained the ability indicated by the outcome.

Senior Exit Survey

Outcome 1		
F16 – S18	F16 – S19	F18 – S20
94%	94%	94%

Student Outcome 2: Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline.

Outcome 2 is directly assessed along two specific traits:

- Students can identify and design a computing-based solution to meet a given set of computing related computing requirements.
- A running and usable software system was developed.

In Course Direct Assessment Details

We use the general rule of thumb of attainment of 70% of students falling in the Excelling and Practicing levels of achievement as a marker for identifying potential action items for strategic and tactical changes to the curriculum.

Semester	Course	Trait	E	P	A	N	E/P	E/P/A	Action
Fa 2019	4620	1	20	20	40	20	40	80	Flag
		2	80	20	0	0	100	100	None
			60	40	0	0	100	100	None
			100	0	0	0	100	100	None
	3300	1	85	0	10	5	85	95	None
			50	10	25	15	60	85	Observe
			75	0	0	25	75	75	None
			85	0	0	15	85	85	None
			30	20	25	25	50	75	Observe
		2	30	15	5	50	45	50	Flag
			40	10	0	50	50	50	Flag
			40	20	25	35	60	85	Observe
			70	0	0	30	70	70	Observe
		3	80	0	0	20	80	80	None
			60	0	0	40	60	60	Observe
			65	0	5	30	65	70	Observe
			13	33	37	17	47	83	Flag
	2310	1	40	37	13	10	77	90	None
			53	27	8	11	81	89	None
		2	48	16	11	24	64	76	Observe
			37	23	29	11	60	89	Observe

Semester	Course	Trait	E	P	A	N	E/P	E/P/A	Action
Sp 2019	4620	1	7	53	20	20	60	80	Observe
		2	100	0	0	0	100	100	None
			67	33	0	0	100	100	None
			87	13	0	0	100	100	None
Fa 2018	2310	1	69	1	4	26	70	74	None
			64	15	4	17	79	83	None
			78	10	3	9	88	91	None
			32	29	14	24	61	76	Observe
Sp 2018	4620	1	27	47	20	7	74	94	None
		2	93	0	7	0	93	100	None
			87	13	0	0	100	100	None
			93	0	7	0	93	100	None

Earlier phases of the program (as indicated in the 2310 and 3300 assessments) point to adequate formative achievement, with the senior capstone demonstrating adequate attainment of the skills upon graduation. The senior capstone assessment indicates a need for higher consistency in the identification of projects, which would provide students with the ability to demonstrate acceptable outcome levels. The department must work amongst faculty to standardize the achievement/attainment levels in the rubrics so that a consistent Excelling, Practicing, Apprentice, and Novice measure is identified. This was especially observed in the traits marked flagged and observed measured in CSC 3300. The faculty member used a mapping of 90-80-70-60 to each of the EPAN levels. This standard is likely too strict.

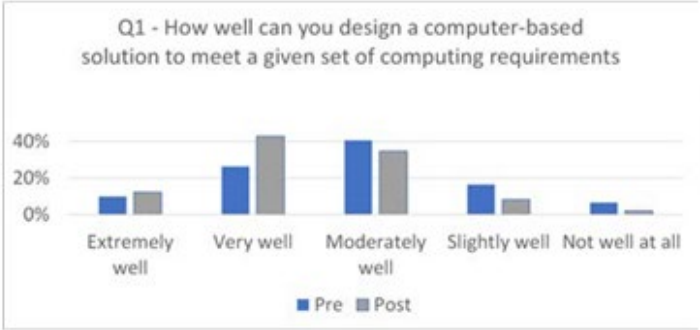
Indirect Assessments

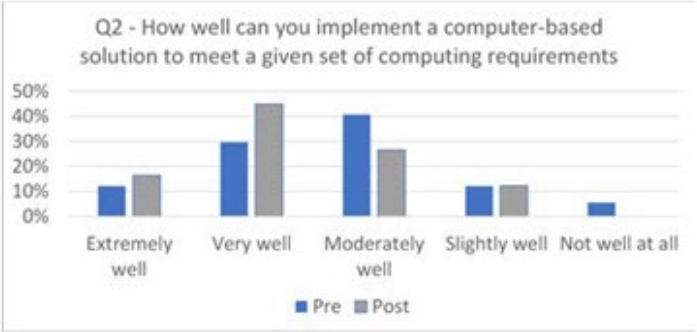
We conducted two different levels of indirect assessments: pre-post surveys for selected courses, and senior exit surveys. The pre-post surveys measure student perceptions of learning based on three different questions posed to the students at the beginning and end of the semester:

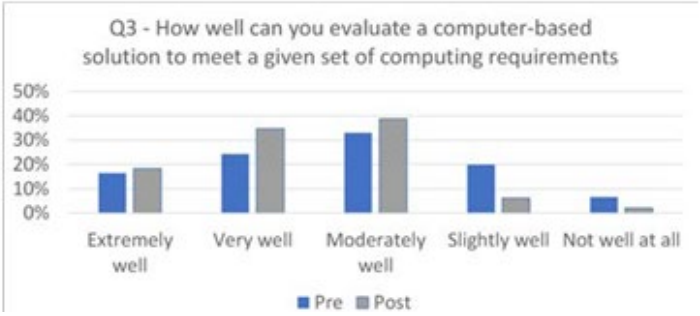
- Q1 - How well can you design a computer-based solution to meet a given set of computing requirements?
- Q2 - How well can you implement a computer-based solution to meet a given set of computing requirements?
- Q3 - How well can you evaluate a computer-based solution to meet a given set of computing requirements?

The statistical results for these surveys using a one- tailed Student's T-Test, with the Fall 2019 surveys indicated a statistical significance in the change of the means.

Pre-Post Fall 2019 - CSC 3300







The senior exit surveys, conducted when students complete the program, ask three identical questions to the pre-post surveys. The results of the surveys are below with the percentage of students responding either “Excellent” or “Good”.

Senior Exit Surveys

Outcome 1		
F16 – S18	F16 – S19	F18 – S20
94%	94%	94%

Students indicate that they have gained the ability to design, implement, and evaluate a computing-based solution.

Student Outcome 3: Communicate effectively in a variety of professional contexts.

Outcome 3 is directly assessed along three specific traits:

- Students can effectively communicate information regarding their experiences in a professional context.
- Students can effectively present technical information to an audience.
- Students can effectively summarize and communicate technical information and ethical arguments in a written form.

In Course Direct Assessment Details

We use the general rule of thumb of attainment of 70% of students falling in the Excelling and Practicing level of achievement as a marker for identifying potential action items for strategic and tactical changes to the curriculum.

Semester	Course	Trait	E	P	A	N	E/P	E/P/A	Action
Sp 2020	3040	1	57	39	4	0	96	100	None
			71	21	0	7	92	92	None
			96	4	0	0	100	100	None
		2	63	25	13	0	88	101	None
		3	13	87	0	0	100	100	None
			37	63	0	0	100	100	None
Fa2019 Sp2020	4610 4620	1	93	7	0	0	100	100	None
			84	16	0	0	100	100	None
		2	75	17	8	0	92	100	None
			83	8.5	8.5	0	91.5	100	None
Sp 2019	3040	1	88	12	0	0	100	100	None
			71	12	0	0	83	83	None
		2	81	12	3	3	93	96	None
		3	60	26	9	5	86	95	None
Sp 2019	4620	1	66	27	7	0	93	100	None
			74	13	13	0	87	100	None
			80	7	13	0	87	100	None
		2	76	18	8	0	94	102	None
			62	23	15	0	85	100	None

Students have demonstrated the ability to communicate in a wide variety of forms. Previous, instructors have noted that writing is probably the weakest skill. In one CSC 3040 section in Spring 2020, the instructor used (and recommends for future sections) the use of a TA with a background in English. The instructor also instituted a built-in feedback loop to the written assignments where students submitted drafts and peer-reviewed each other's work, and they could ask for direct feedback from the instructor and TA – this resulted in much better papers from previous semesters.

Indirect Assessments

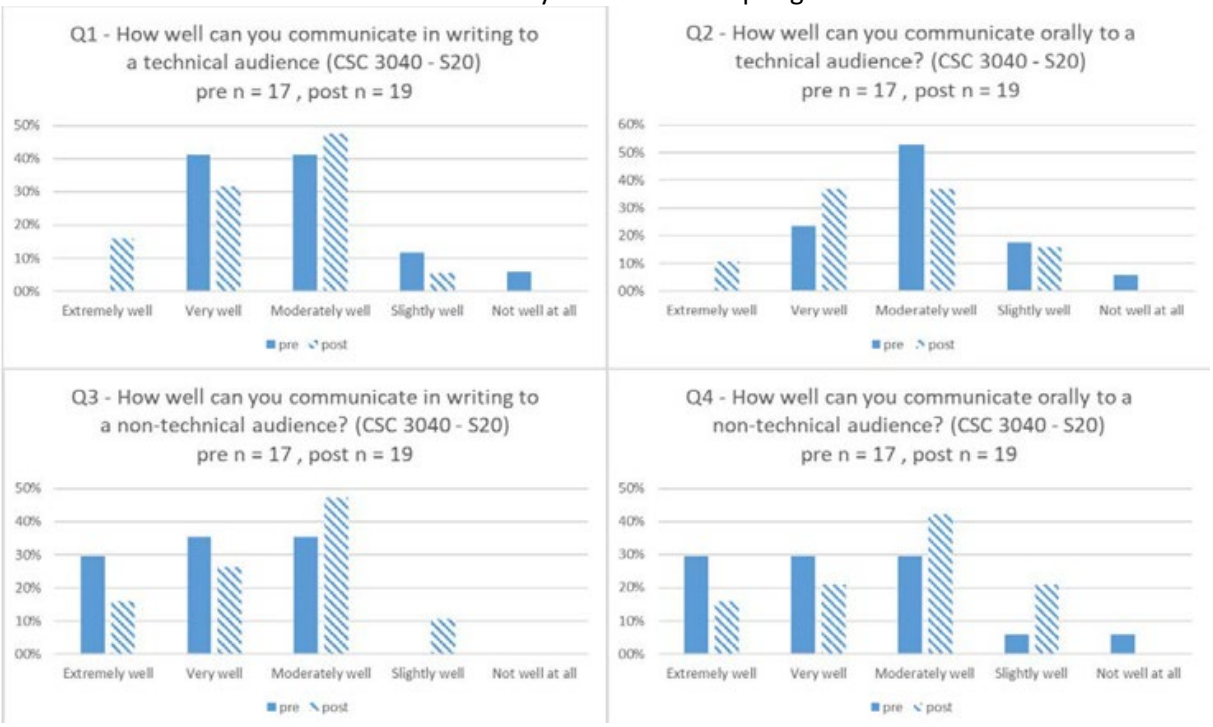
We conducted two different levels of indirect assessments: pre-post surveys for selected courses, and senior exit surveys. The pre-post surveys measure student perceptions of learning based on four different questions posed to the students at the beginning and end of the semester:

1. How well can you communicate technical information in writing to a technical audience?
2. How well can you communicate technical information in writing to anon-technical audience?
3. How well can you communicate technical information orally to a technical audience?
4. How well can you communicate technical information orally to a non-technical audience?

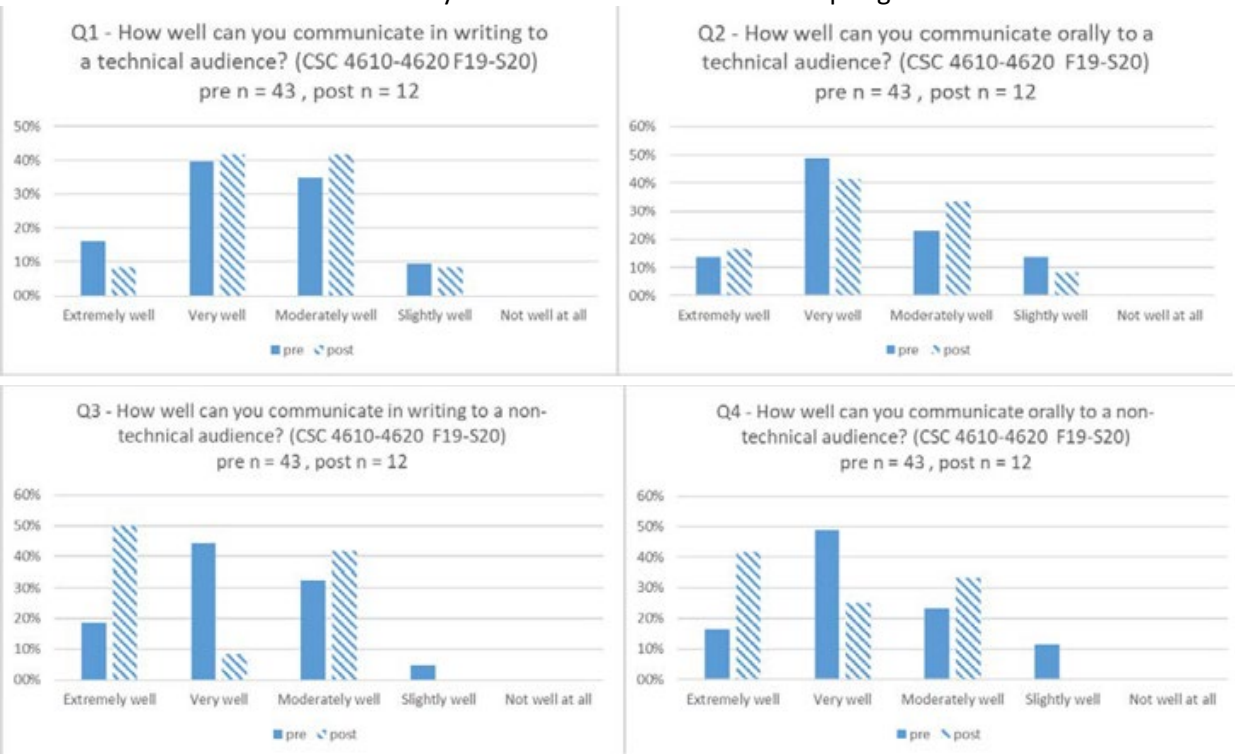
The statistical results for these surveys using a one- tailed Student's T-Test, with the Fall 2019 surveys indicated a statistical significance change of the means.

The data shown indicates a statistically significant change in the means as measured using the Student's T-Test. Student in CSC 3040, indicate lower perceptions of improvement for communicating with non-technical audiences. However, there is a higher improvement in perception of communication with non-technical audiences in the capstone courses, particularly in the second semester (S20).

Pre-Post Surveys for CSC 3040 Spring 2020



Pre-Post Surveys for CSC 4610-4620 Fall 2019-Spring 2020



The senior exit surveys, conducted when students complete the program, asks four questions. The results of these surveys are below with the percentages representing student responses of either "Excellent" or "Good". In general, this points to students' perception that they have gained the ability indicated by the outcome.

Senior Exit Surveys

Outcome 3		
F16 – S18	F16 – S19	F18 – S20
80	83	92

Student Outcome 4: Recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.

Outcome 4 is directly assessed along seven specific traits:

- Students can recognize responsibilities as a computing
- Students can recognize, identify, and describe ethical concepts related to
- Students can recognize, identify, and describe legal concepts related to
- Students can analyze the challenges associated with ethical concepts in the context of computing.
- Students can analyze the challenges associated with legal concepts in the context of computing.

- Students can apply ethical concepts to assess computing
- Students can apply legal concepts to assess computing

It should be noted that, while the specific traits are similar, they were split (starting in Fall 2019) to provide a cleaner, and the department's realization that there were multiple skills specified in what had been previous treated as a single trait.

In Course Direct Assessment Details

We use the general rule of thumb of attainment of 70% of students falling in the Excelling and Practicing levels of achievement as a marker for identifying potential action items for strategic and tactical changes to the curriculum.

Semester	Course	Trait	E	P	A	N	E/P	E/P/A	Action
Fa 2019	3040	1	70	0	0	30	70	70	None
		2	0	20	30	50	20	50	Flag
			35	0	30	35	35	65	Flag
		3	70	10	10	10	80	90	None
			20	20	10	50	40	50	Flag
		4	70	10	10	10	80	90	None
			20	5	35	40	25	60	Flag
		5	80	10	0	10	90	90	None
			55	5	15	25	60	75	Flag
		6	25	25	15	35	50	65	Flag
			80	20	0	0	100	100	None
		7	20	15	15	50	35	50	Flag
			85	0	0	15	85	85	None
	4570	1	72	24	3	0	96	99	None
Fa 2018	4570	1	73	20	3	3	93	96	None
	3040	1	26	31	30	13	57	87	Flag
			37	26	18.5	18.5	63	81.5	Observe
		2	74	11	11	4	85	96	None
			59	15.5	5.5	17	74.5	80	None
		3	7	24	11	57	31	42	Flag
			7	24	43	26	31	74	Observe

In Fall 2019, CSC 3040 students did not attain the 70% goal on 6 of the 7 traits. The instructor noted that students know the definitions of the various legal terms but do not fully understand how to apply them. In response to this observation, the instructor recommends that students need to be exposed to more scenarios and discussions regarding their appropriate application. In addition, it was also noted that ethics was covered in more detail in the first half of the semester with a little application in the second half, which may be the reason for the disparity in "excelling" versus "novice" between the mid-

term and the final. In response to this discrepancy, the instructor (along with the instructor for CSC 3040 in Fall 2018) recommends that future offerings should consider putting all ethics material in the first half of the semester, with the second half spent solely on writing.

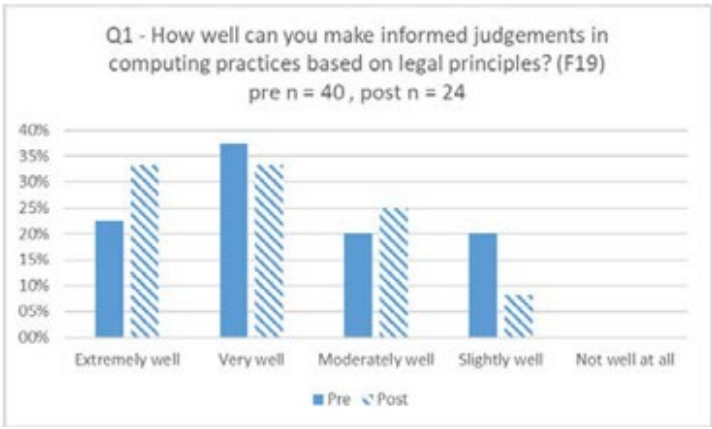
Indirect Assessments

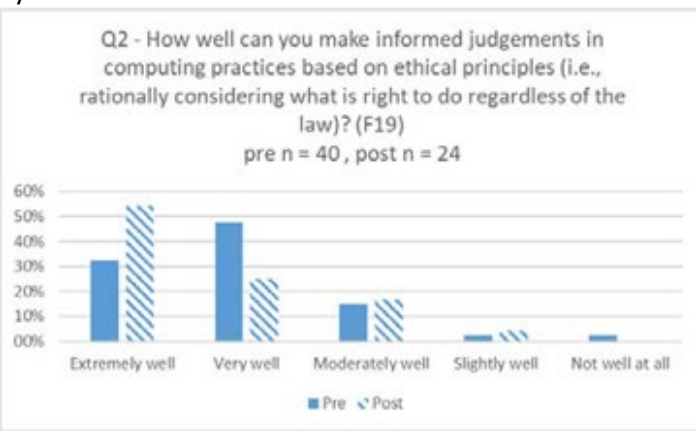
We conducted two different levels of indirect assessments: pre-post surveys for selected courses, and senior exit surveys. The pre-post surveys measure student perceptions of learning based on two different questions posed to the students at the beginning and end of the semester:

1. How well can you make informed judgements in computing practices based on legal principles?
2. How well can you make informed judgements in computing practices based on ethical principles?

The statistical results for these surveys using a one- tailed Student's T-Test, with the Fall 2019 surveys indicated a statistical significance change of the means.

Pre-Post Surveys for F19





The senior exit surveys, conducted when students complete the program, asks four questions. The results of these surveys are below with the percentages representing student responses of either "Excellent" or "Good". In general, this points to students' perception that they have gained the ability indicated by the outcome.

Senior Exit Surveys

Outcome 4		
F16 – S18	F16 – S19	F18 – S20
81	83	87

Student Outcome 5: Function effectively as a member or leader of a team engaged in activities appropriate to the program's discipline.

Outcome 5 is directly assessed along three specific traits:

- Students can create, track, and manage a plan (assessed by group).
- Students can effectively participate as members of a team.
- Students can produce working deliverables (i.e., a minimum viable product).

In Course Direct Assessment Details

We use the general rule of thumb of attainment of 70% of students falling in the Excelling and Practicing levels of achievement as a marker for identifying potential action items for strategic and tactical changes to the curriculum.

Semester	Course	Trait	E	P	A	N	E/P	E/P/A	Action
Sp 2020	3040	1	29	14	14	7	64	85	Flag
			14	64	18	4	78	96	None
Fa2019 Sp2020	4610 4620	1	60	7	26	7	67	93	Observe
		2	51	17	25	7	68	93	Observe
			68	24	8	0	92	100	None
		3	76	24	0	0	100	100	None

CSC 3040 used peer evaluations to measure the students' ability to participate as members of a team. Students in that course attained to requisite 70% threshold, reflecting that students can successfully function as members of a team.

In general, for the capstone sequence, students met the levels of attainment that were expected. The exceptions were on Trait 1 (create and manage a plan) and one of the two measures for Trait 2 (track and manage a plan) in the Fall 2019/Spring 2020 capstone sequence as well as one of the two metrics for Trait 2 (effectively participate as members of a team) in the Spring 2019 CSC 4620. The instructors recommend including more project management learning into the course along with more mentoring and accountability at the level of the individual students to improve these levels of attainment. The instructor also noted that attainment might be better measured by assessing only the iteration reports from later in the course in addition to capturing data about team conflict, both strategies that might help assess attainment.

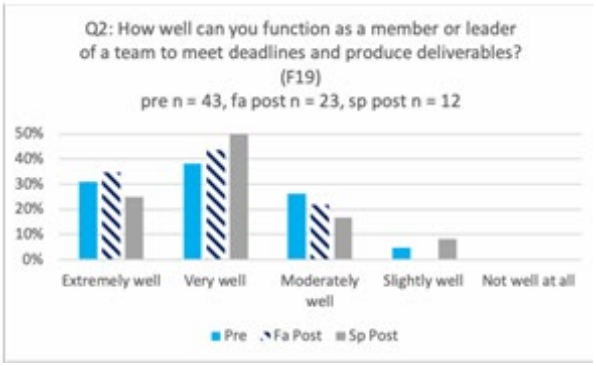
Indirect Assessments

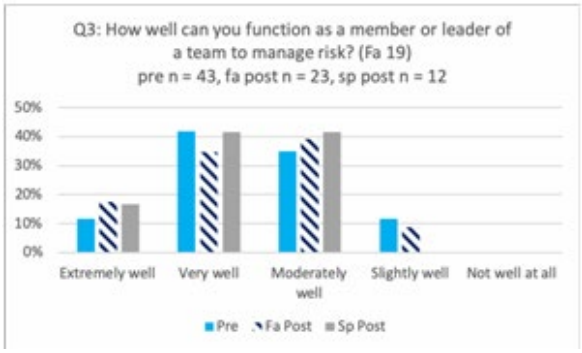
We conducted two different levels of indirect assessments: pre-post surveys for selected courses, and senior exit surveys. The pre-post surveys measure student perceptions of learning based on three different questions posed to the students at the beginning and end of the semester:

1. How well can you function on as a member or leader of a team to establish goals and plan tasks?
2. How well can you function on as a member or leader of a team to meet deadlines and produce deliverables?
3. How well can you function on as a member or leader of a team to manage risk?

The statistical results for these surveys using a one- tailed Student's T-Test, indicated no statistical significance change of the means. However, students' perceptions of functions as a team to manage risk has improved. Students may also realize that their initial estimates of their abilities (as scored on the pre-survey) were incorrect.

Pre-Post Surveys





The senior exit surveys, conducted when students complete the program, asks four questions. The results of these surveys are below with the percentages representing student responses of either "Excellent" or "Good". In general, this points to students' perception that they have gained the ability indicated by the outcome.

Senior Exit Surveys

Outcome 5		
F16 – S18	F16 – S19	F18 – S20
85%	87%	85%

Student Outcome 6: Apply computer science theory and software development fundamentals to produce computing-based solutions.

Outcome 6 is directly asses along two specific traits:

- Students can apply computer science theory and software development fundamentals to design computing-based solutions.
- Students can apply computer science theory and software development fundamentals to implement computing-based solutions.

In Course Direct Assessment Details

We use the general rule of thumb of attainment of 70% of students falling in the Excelling and Practicing levels of achievement as a marker for identifying potential action items for strategic and tactical changes to the curriculum.

Semester	Course	Trait	E	P	A	N	E/P	E/P/A	Action
Sp 2020	2310	1	66	23	6	6	89	94	None
			77	6	9	9	83	91	None
			45	9	30	15	54	85	Observe
		2	49	6	23	23	54	77	Observe
			60	3	26	11	63	89	Observe
	4575	1	87	13	0	0	100	100	None
			42	47	0	11	90	90	None
			66	27	0	5	93	93	None
		2	53	32	3	13	84	87	None
Sp 2019	2310	1	18	45	27	9	64	91	Observe
			48	32	16	5	80	95	None
			39	34	16	11	73	89	None
		2	36	43	11	9	79	91	None
			30	32	23	16	61	84	Observe
	4575	1	93	0	6	0	93	99	None
			65	26	9	0	91	100	None
		2	78	17	4	0	95	99	None

While we assess this outcome in CSC 2310, that course is relatively early in the curriculum and is not a good measure of outcome attainment by the time of graduation. We collect assessments in that course to serve more as a formative assessment of the outcome to inform us of our students' development over time. The data in that course does indicate that at that time in the curriculum, students are not yet demonstrating attainment of this outcome. The CSC 4575 data, however, shows that, in that class, all assessment for both traits for both years surpass the requisite 70% threshold. That being the case, the teaching team did not make any outcome-specific recommendations.

In the latest window of the major field test, a "buy-in" issue arose that severely affected our use of this assessment tool. In Fall 2019, we observed a significant change in the administration of the test. A requirement mandating that the test be made a requirement for graduation was previously not enforced by the department. The enforcement of this requirement was met with a significant backlash from students. Furthermore, in Spring 2020, the administration of the test by ETS was severely degraded due to the use of online testing requiring third-party administration. For example, many students were unable to take the test due to ETS-provided proctors not attending scheduled appointments.

Major Field Test

Cohorts					
Category	F14 - S16	F15 - S17	F16 - S18	F17 - S19	F18-S20*
Programming	75.8	82.6	88.4	90	55
Overall	82.9	89.4	93.2	93	56.5
Satisfactory	70	70	70	70	70

Indirect Assessments

We conduct pre-post surveys in course to directly assess student work to determine student perceptions of learning. The sample size for the post survey Spring 2020 CSC 4575 survey was only three students. This was, however, after campus closed due to COVID-19. Thus, the only informative indirect assessment available for this outcome was our senior exit survey, and that data indicates the students are currently satisfied with their attainment of this outcome.

We also conduct a senior exit survey that asks students to rate how well students believe Tennessee Tech did in helping them attain each Learning Outcome. Our two-year moving average on Outcome 6, indicates that for the past several years, more than 70% of respondents indicated that the University performed as "excellent" or a "good" (on a 5-level Likert scale) at helping them attain this Outcome.

Senior Exit Surveys

Outcome 6		
F16 – S18	F16 – S19	F18 – S20
85%	89%	92%

Modifications for Continuous Improvement

Student Outcome 1: Fall 2019 data from CSC 4610 identified potential changes were needed as attainment fell below our 70% threshold for both Trait1 and Trait 2. Our discussions on these skills have led to identifying a need to focus on both the mindset and mechanics of requirements definitions through user stories so that the focus is not just on the rote practices, but also their usage in practice. The teaching team recommends creation of transferable knowledge from the Fall 2018 instructor and the Fall 2019 instructors, and development of more in-depth learning materials on the use of user stories. In particular, the instructors state that we "need to provide more examples and exercises for writing good user stories. We know from past experiences that the students get better at this in the

following semester (as they continue to work on their project), but we need to think about getting them more experiences earlier."

Student Outcome 4: In the 2019-2020 academic year, we flagged a number of potential issues related to Student Outcome 4: Professionalism. As this outcome is addressed primarily in a single course, we made the following changes for the next academic year, including:

- Faculty assignments – faculty assigned to teach this course have been rather variable over the past few years, making it difficult for anyone to achieve flow or create a stable curriculum. In AY 2020-2021, this course will be assigned to a single faculty member.
- Teaching assistants – the CSC 3040 course (Professionalism, Communication, and Research in Computing) has employed computer science graduate students as teaching assistants. We began a partnership with the Department of Communication and Journalism to hire students in the technical communication field to support this course.

Appendices

1. Curriculum Map

Appendix 1: Curriculum Map

Computer Science – Student Learning Outcomes and Curriculum Map

1. Analyze a complex computing problem and apply principles of computing and other relevant disciplines to identify solutions.
2. Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline.
3. Communicate effectively in a variety of professional contexts.
4. Recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.
5. Function effectively as a member or leader of a team engaged in activities appropriate to the program's discipline.
6. Apply computer science theory and software development fundamentals to produce computing-based solutions.

	Outcome Relevancy Level (L = Low or None, M = Medium, H = High)					
	1	**2**	**3**	**4**	**5**	**6**
CSC 1200 - Principles of Computing	H	H	L	L	L	L
CSC 1300 - Intro to Problem Solving and Computer Programming	H	H	L	L	L	L
CSC 1310 - Data Structures and Algorithms	H	H	L	M	L	H
CSC 2310 - Object-Oriented Programming and Design	H	H	L	L	L	H
CSC 2400 - Design of Algorithms	H	H	L	L	L	M
CSC 2500 - Unix Laboratory	L	L	L	L	L	L
CSC 2560 Networks for Information Technology	H	H	L	L	L	H
CSC 2700 - Discrete Structures for Computer Science	L	L	L	L	L	L
CSC 3020 Numerical Methods	H	H	L	L	L	M
CSC 3040 – Professionalism, Communication, and Research in Comp	L	L	H	H	L	L
CSC 3220 Fundamentals of Data Science	H	H	M	M	M	L
CSC 3230 Healthcare Data Analytics	H	H	M	H	L	H
CSC 3300 - Database Management Systems	M	M	L	L	L	M
CSC 3410 - Computer Organization and Assembly Lang Programming	H	M	L	L	L	M
CSC 3710 - Foundations of Computer Science	M	M	L	L	L	M
CSC 4010 Programming Languages	H	H	L	L	L	H
CSC 4040 Undergraduate Computing Research Experience	H	H	M	M	L	H
CSC 4100 (5100) - Operating Systems	M	L	L	L	L	H
CSC 4200 (5200) – Computer Networks	M	M	L	L	L	H
CSC 4220 Data Mining and Machine Learning	H	H	M	M	M	L
CSC 4240 Artificial Intelligence	M	L	L	M	M	L
CSC 4320 (5320) - Computer Architecture	M	L	L	L	L	M
CSC 4400 Analysis of Algorithms	H	M	L	L	L	M
CSC 4570 IT Security	H	L	M	H	H	L
CSC 4575 Information Assurance and Cryptography	H	L	H	H	H	L
CSC 4580 Software Reverse Engineering	H	H	L	L	L	H
CSC 4610 - Software Engineering I	H	H	H	H	H	H
CSC 4620 - Software Engineering II	H	H	H	H	H	H
CSC 4710 Design and Development of Human/Web Interfaces	H	H	M	M	M	H
CSC 4750 Computer Graphics	H	M	L	L	L	H
CSC 4760 Parallel Programming	M	H	L	L	L	H
CSC 4770 Distributed and Cloud Computing	M	H	L	L	L	L
CSC 4990 Computer Science Internship	M	M	H	H	H	M