2021-2022 Assessment Report for Department: *Computer Science & Engineering*

General Education Core Curriculum Area:

Undergraduate Major: *Computer Science*

Department Mission Statement:
The mission of the Computer Science Program is to produce computer science graduates who, trained in the design, implementation, and analysis of computational systems and skilled in technical communication, will contribute towards the advancement of computing science and technology.

Program Outcomes (*a.k.a.* *Student* Outcomes):
The current outcomes, derived largely from ABET-CAC requirements, are the following.

By the time of their graduation, the undergraduate academic program in Computer Science should enable our graduates to

1. Analyze a complex computing problem and to 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; and
6. Apply computer science theory and software development fundamentals to produce computing-based solutions.

Note[1]: The above program / student outcomes are ABET outcomes.

[1] This addresses a comment we received from a past review.

Curricular Map:

Each numeric entry in the matrix below (between 1 and 3) represents the relative weight / contribution of a required course (row) towards a program / student outcome (column). *Note*[2]: This *final* matrix was obtained after trimming entries with smaller contributions (= 1) in an *initial* matrix in order to keep the assessment effort manageable. This is why there are no 1-entries and the row for CSE 101 is blank. In 2022, the Chair added CSE 382 to outcome column 3 after observing that the CSE 382 instructor was heavily assessing communications in their course assessment report.

Required Courses	Program/Student Outcomes					
	1. Analyze a complex computing problem and to 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
CSE 101						
CSE 113		**2**				
CSE 122		**2**				
CSE 213		**2**				
CSE 221		**2**				
CSE 222		**2**				
CSE 241						**2**
CSE 324	**3**	**3**				
CSE 325	**3**				**3**	
CSE 326			**3**		**3**	**3**
CSE 331	**3**		**2**			
CSE 342						**3**
CSE 344						**3**
CSE 353	**2**	**3**				
CSE 382			**2**	**3**		
CSE 423	**3**	**3**				**3**

[2] 2 This addresses a comment we received from a past review.

Our process:

- The above curricular map was obtained by first considering all courses and assigning weights between 1 and 3 (inclusive) to reflect the strength of their contribution, with the following interpretation.

Contribution	*Interpretation*
1	Introductory / preliminary
2	Reinforcement / extension / application
3	Major component

Next, it was pruned keeping only the required courses, and then pruning it further by eliminating weights of 1 and 2 unless one of three criteria (omitted here) were met.

- For each Program (/Student) Outcome, we obtain a number between 1 and 4 through a weighted sum of scores from contributing courses as per the curricular map shown above. Our acceptance threshold for each student outcome is 3.0.
- The scores from contributing courses come from the respective instructors who are required to submit an assessment report for each offering of such courses. This report outlines the relation between the scores and the course learning outcomes.
- The report also provides comments regarding successful strategies and plans for future modifications. While we have a numeric acceptance threshold, the instructors' comments are always important.
- The numeric score for the j^{th} student outcome is a normalized weighted sum

$$Score\_Outcome_j = \frac{\sum_i (n_{ij} * s_{ij})}{\sum_i n_{ij}}$$

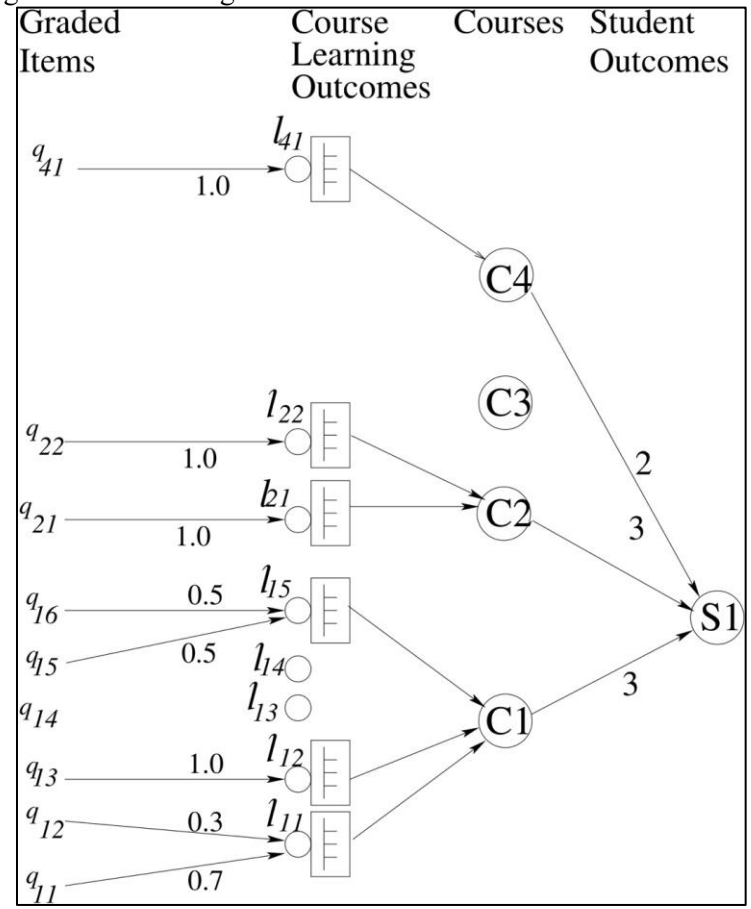
where the weights n_{ij} are the non-zero entries in the column for student outcome *j* in the curricular map, and each value s_{ij} is a score that comes from the assessment of the i^{th} course specifically for the j^{th} Student outcome. For example, the curricular map shows that Student outcome 3 (technical communication) will be measured using three courses CSE326 Software Engineering, CSE423 Compiler Writing, and CSE331 Computer Architecture, with impact factors of 3, 3, and 2 respectively. If the numeric scores assessed by those three courses are 3, 2, and 4 respectively, then the score computed for Student outcome 5 is given by (3*3 + 2*3 + 4*2)/(3+3+2), i.e., 2.88.

We limit the score s_{ij} (reported by a course *i* for a Student outcome *j*) to a number between 1 and 4 with the following interpretation.

Student Outcome score	*Interpretation*	
1	Unsatisfactory	
2	Marginal	
3	Satisfactory	
4	Excellent	

- The instructor of the i^{th} course computes a score s_{ij} for the j^{th} Student outcome as follows.

Example: computing the score for Program/Student Outcome S1 from relevant courses C1, C2, and C4.



The first step is to identify the largest disjoint set *L* of course learning outcomes corresponding to the Student outcome at hand at hand. For that set *L*,

1. The instructor decides on a performance metric to interpret an average score for a course outcome as unsatisfactory, marginal, satisfactory, or excellent, resulting in the basis for a four-point scale; this takes care of variations among courses in grading, e.g., relative versus absolute, partial credit versus all-or-none grading.
2. Each course outcome l in *L* is tied to a set of gradable items in the course, e.g., a project, specific questions in the final exam, a presentation, etc. The sets of items should be disjoint among learning outcomes. In the above figure, course outcome l_{11} would be tied to questions q_{11} and q_{12}.
3. Weights are assigned to these questions or items (in Figure 1, 0.7 and 0.3 for questions q_{11} and q_{12} respectively); using them, a formula is written to compute a normalized weighted sum from the scores for those questions or items;
4. From a table of scores of the students on those gradable items, one numeric score is computed for each student per course outcome l.
5. Those numeric scores are then averaged over the whole class to get one numeric score p_l for each course outcome l.
6. Using the performance metric, a number q_l is obtained by quantizing p_l to a four-point scale.
7. The above is repeated for each l in *L*.
8. The scores q_l (in the four-point scale) are averaged over all l in *L*.

The result is s_{ij}, the numeric score (between 1 and 4) from course i to student outcome j.

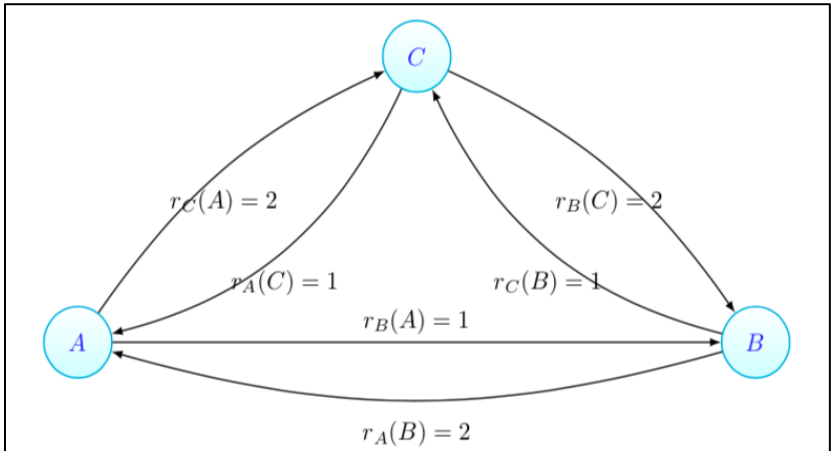
- *New assessment method for team (/group) work.*
We found it quite difficult to measure the effectiveness of teamwork using direct measures. Invariably, the instrument became corrupted with the quality of the projects or deliverables. The issues differed with the content of the courses; a workable solution for all concerned courses proved elusive. Beginning in Spring 2019, we decided to use an indirect measure using surveys following a suggestion of Dr. Gloria Rogers, the facilitator of an assessment workshop organized at NMT by AVPAA Peter Mozley. We adopted three yardsticks from her examples and constructed the following computational scheme to obtain a numeric measure consistent with our scheme.

  First, we chose three team performance yardsticks:
  - fulfilling team role duties,
  - sharing of teamwork, and
  - listening to teammates.

  For each of those yardsticks, for each group, the following information was obtained. Each individual in the group was rated on that yardstick by each of his/her team-mates on a *0..M* scale.
  The information (for a given yardstick and given group) is modeled using a weighted directed graph. Each member of the group is represented by a vertex; each rating of a member *u* by member *v* is represented by an out-edge from *u* to *v*, the weight on that edge being the rating (a number in *0..M*.
  - A *member interaction* metric for each team member is then defined as the sum of the weights on the out-edges from the vertex representing that member divided by the maximum possible sum, which is *(N-1)*M*.

- The *group interaction* for a group is essentially an average over all its members. But since that average is in the closed interval [0,1], it is translated to 1..4 by multiplying by 3 and adding 1 (a linear transformation).
- The *interaction* on a given yardstick is the average over all the groups in the class.
- Finally, the averages of the three yardsticks is the *class team work* measure for the entire class.

The following example outlines the initial steps of our method. Suppose the following graph captures the result of a survey of a group with members *A, B,* and *C* for a given yardstick using a rating scale of 0..3. The sum of the two out-edges from *A* is 3 (A is rated 2 and 1 by C and B respectively) while the maximum such sum is 3*(3-1) = 6 (the scenario in which both would have rated *A* at 3); thus the interaction of *A* is 3/6 = 0.5. Similarly, the interaction of *B* and *C* are also 0.5; thus the interaction of the group (on this yardstick) is 0.5; that is transformed into 2.5 on our 4 point scale.



Example of a team with $N = 3$ members A, B, and C. A rates B and C at 2 and 1 respectively.
$r_C(A) = C$'s rating of A's interaction
$r_B(A) = B$'s rating of A's interaction

Since A is rated 2 and 1 (using a rating scale from 0 to 3) by C and B respectively, the member interaction of A is given by:

$$memberinteraction(A) = \frac{(r_c(A) + r_B(A))}{(2 \times 3)} = \frac{(2+1)}{(2 \times 3)} = \frac{2}{3}$$

The group interaction (1..4) for an n-member group is defined as follows.

$$average\ member\ interaction = \frac{1}{n} \sum_{i=1}^{n} interaction(i)$$

$$group\ interaction = 1 + 3 \times average\ member\ interaction$$

Assessment Instrument for team (/group) work: We ask each participant to rate the others in the group on a 0 to 3 scale, enter the data in a spreadsheet, and compute the interaction score for each group using the above. The students are informed that the survey results will not impact their grades.

Assessment of Team Activity

Note: This will be used for course assessment, not for grading.

Using the following rubric, rate each of your team mates (do not rate yourself) in a **0** to **3** scale on three yardsticks:

1. Fulfilling team role duties
2. Sharing of team work
3. Listening to teammates

Your Name:

	Fulfilling team role duties	Sharing of team work	Listening to teammates
0 = Unsatisfactory	does not perform any duties of assigned team role	always relies on others to do the work	never allows others to speak
1 =Developing	inconsistently performs assigned duties	rarely does assigned work: often needs reminding	usually does most of the talking; rarely allows others to speak
2 = Satisfactory	performs assigned duties needs reminding	usually does assigned work	listens most of the time
3 = Exemplary	performs all duties assigned and actively assists others	always does assigned work without needing reminders	consistently listens and responds to others appropriately
Name of team-mate	0 1 2 3	0 1 2 3	0 1 2 3
Name of team-mate	0 1 2 3	0 1 2 3	0 1 2 3
Name of team-mate	0 1 2 3	0 1 2 3	0 1 2 3

(circle your choices)

Rubric for assessment of teamwork.

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

<table>
<tr><th>Student Learning Outcomes</th><th>Assessment Procedures</th><th>Assessment Results</th><th>Assurance</th></tr>
<tr><td>Learning Outcomes of the Program—Students will be able to:</td><td>Process/Instrument used:
Direct measures. Graded items are weighted and linked to courses; courses are weighted, aggregated, and linked to student outcomes. Covered Fall 2021, and Spring 2022.</td><td>What were your findings?
Score range: 1 (unsatisfactory),
2 (marginal),
3 (satisfactory), and
4 (excellent).</td><td>Our department believes we fulfill this Learning Outcome because:
(state evidence in 30 words or less)</td></tr>
<tr><td>1. Analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions</td><td>Direct Measure:

Quantitative Assessment Procedure on CSE 324, 325, 331, 353, and 423.</td><td>
<table>
<tr><th>Course</th><th>Score</th><th>Weight</th><th>Overall</th></tr>
<tr><td>CSE 324 S22</td><td>4</td><td>3</td><td rowspan="5">3.5</td></tr>
<tr><td>CSE 325 F21</td><td>3.8</td><td>3</td></tr>
<tr><td>CSE 331 S22</td><td>3.71</td><td>3</td></tr>
<tr><td>CSE 353 F21</td><td>3</td><td>2</td></tr>
<tr><td>CSE 423 S22</td><td>3</td><td>3</td></tr>
</table>
</td><td>the overall scores for both Student outcome 1 is higher than 3.0, our acceptance threshold.</td></tr>
</table>

Adjustment/Improvement
CSE 324: I offered most of the class quizzes online for 24 hours (over the weekend), which allowed the students to study for the quiz and relax at home answering it. CSE 325: CSE 331: CSE 353: The performance of outcome 6 is significantly improved compared to past two offerings. This proves that my strategy of giving more in-class examples and assignments is effective. CSE 423: see planned adjustments described at SO #2.

#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

<table>
<tr><th>Student Learning Outcomes</th><th>Assessment Procedures</th><th>Assessment Results</th><th>Assurance</th></tr>
<tr><td>Learning Outcomes of the Program—Students will be able to:</td><td>Process/Instrument used:
Direct measures. Graded items are weighted and linked to courses; courses are weighted, aggregated, and linked to student outcomes. Covered Fall 2021, and Spring 2022.</td><td>What were your findings?
Score range: 1 (unsatisfactory),
2 (marginal),
3 (satisfactory), and
4 (excellent).</td><td>Our department believes we fulfill this Learning Outcome because:
(state evidence in 30 words or less)</td></tr>
<tr><td>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</td><td>Direct Measure: Quantitative Assessment Procedure (see below) of CSE <s>113,</s> 122, 221, 222, 324, 353, and 423. Note: as of 12/3/2022 no assessment data was received from CSE 113 instructors for 2021-2022, one of whom left NMT in August 2022.</td><td>
<table>
<tr><th>Course</th><th>Score</th><th>Weight</th><th>Overall</th></tr>
<tr><td>CSE 113 F21</td><td>No data</td><td>1</td><td rowspan="9">3.3</td></tr>
<tr><td>CSE 113 S22</td><td>No data</td><td>1</td></tr>
<tr><td>CSE 122 F21</td><td>3</td><td>1</td></tr>
<tr><td>CSE 122 S22</td><td>3</td><td>1</td></tr>
<tr><td>CSE 221 F21</td><td>4</td><td>2</td></tr>
<tr><td>CSE 222 S22</td><td>4</td><td>2</td></tr>
<tr><td>CSE 324 S22</td><td>3.33</td><td>3</td></tr>
<tr><td>CSE 353 F21</td><td>4</td><td>3</td></tr>
<tr><td>CSE 423 S22</td><td>2</td><td>3</td></tr>
</table>
</td><td>the overall score is higher than 3.0, our acceptance threshold.</td></tr>
</table>

Adjustment/Improvement
CSE 113: no report received. Department Chair will convene a meeting with current CSE 113 instructors in January 2023 to ensure assessment takes place going forward. CSE 122: The outcomes assessment document does not appear to reflect properly on what went well and what needed improvement in the Fall 2021 covid-affected semester. Reported averages of scores for course outcomes ranged from 73-75% in Fall 2021 and 84-87% in Spring 2022. The instructor who wrote the report is no longer with New Mexico Tech. CSE 221: The instructor did not provide adjustments/improvements. Reported averages of scores for course outcomes ranged from 90-99%, suggesting that the assessed problems were too easy. The instructor who wrote the report is no longer with New Mexico Tech. CSE 222: The instructor did not provide adjustments/improvements. Reported averages of scores for course outcomes ranged from 82-95%. The instructor who wrote the report is no longer with New Mexico Tech. CSE 324: About 20% of the C&D levels students usually show a very noticeable progress through the semester because of their efforts trying to get extra exams points just by paying attention to what I say in the class. I intend to keep doing that in future classes to keep such high score.

CSE 353:

CSE 423: two areas of adjustment have been identified as follows.

Failure to Write a (toy) Compiler: In comparing project grades in Spring 2022 with the previous year, it is apparent that many students were unable to deliver working code in the later phases: semantic analysis and code generation. There was a strong bifurcation, with 22 students successfully delivering most of these latter phases, and 14 students receiving few or no points on these assignments. The course final grades were similar, with a high number (11/36) of students receiving a D or an F.
The reasons many students failed on their coding may be partly due to the instructor, the difficulty of the language that students were asked to write a compiler for (a Java subset), or the students being less prepared for a large-scale coding effort than in previous years. For example, in 2021 CSE 325 Operating Systems, which was supposed to deliver a medium-scale programming group project experience in preparation for CSE 423, reduced or eliminated group work and omitted the culminating final (filesystem) project due to covid.

Remediation via a Revised Group Compiler Project: In 2021 the CSE 423 project was individual, partly due to covid and also in order to preclude the likelihood of one student doing all the work on behalf of others on the team who do not contribute or learn the material as intended. In Spring 2022 I made groups optional, feeling like the number of students affected by covid or otherwise attending remotely would still impair their ability to do full group team projects. In Spring 2023 I will change the semester project to make it more appropriate for a group project and proceed with a software-engineering-style team orientation for most assignments. I will also change the language for which students are asked to write a compiler and provide more hands-on assistance during the scheduled lab hour and in required team meetings. Hopefully the group software-engineering style will improve students' ability to get their compiler working successfully.

#3 Communicate effectively in a variety of professional contexts

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<tr><th>Student Learning Outcomes</th><th>Assessment Procedures</th><th>Assessment Results</th><th>Assurance</th></tr>
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Direct measures. Graded items are weighted and linked to courses; courses are weighted, aggregated, and linked to student outcomes. Covered Fall 2021, and Spring 2022.</td><td>What were your findings?
Score range: 1 (unsatisfactory),
2 (marginal),
3 (satisfactory), and
4 (excellent).</td><td>Our department believes we fulfill this Learning Outcome because:
(state evidence in 30 words or less)</td></tr>
<tr><td>3. Communicate effectively in a variety of professional contexts</td><td>Direct Measure: Quantitative Assessment Procedure (see below) on CSE 326, 331, 382.</td><td>
<table>
<tr><th>Course</th><th>Score</th><th>Weight</th><th>Overall</th></tr>
<tr><td>CSE 326 S22</td><td>3.5</td><td>3</td><td rowspan="3">3.6</td></tr>
<tr><td>CSE 331 S22</td><td>4</td><td>2</td></tr>
<tr><td>CSE 382 S22</td><td>3.4</td><td>2</td></tr>
</table>
</td><td>The overall score is higher than 3.0, our acceptance threshold.</td></tr>
</table>

Adjustment/Improvement
CSE 326: My immediate remedial action will be to refine and continue to have homework on requirement elicitation, analysis, and system design, so that teaching assistants as well as I can provide immediate feedbacks to students who struggle with the topics. My future remedial action will be to look into the latest development in software requirement elicitation and design and will accommodate them into teaching materials. CSE 331: CSE 382: To improve the scores on 4b (Understand and communicate digitally), I plan to provide more instruction (~20 minutes) on design practices and other ways of creating engaging multimedia.

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

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Score range: 1 (unsatisfactory),
2 (marginal),
3 (satisfactory), and
4 (excellent).</td><td>Our department believes we fulfill this Learning Outcome because:
(state evidence in 30 words or less)</td></tr>
<tr><td>4. [Applications:] exposure to one or more computer science application areas;</td><td>Direct Measure: Quantitative Assessment Procedure (see below) on CSE 382.</td><td><table><tr><th>Course</th><th>Score</th><th>Weight</th><th>Overall</th></tr><tr><td>CSE 382 S22</td><td>3.5</td><td>4</td><td>3.5</td></tr></table></td><td>The overall score is higher than 3.0, our acceptance threshold.</td></tr>
</table>

Adjustment/Improvement
CSE *382: Instructor also provided course learning outcomes pertaining to communications that might be used as inputs for SO #3.*

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

<table>
<tr><th>Student Learning Outcomes</th><th>Assessment Procedures</th><th>Assessment Results</th><th>Assurance</th></tr>
<tr><td>Learning Outcomes of the Program—Students will be able to:</td><td>Process/Instrument used:
Indirect measure. Team members were surveyed on three yardsticks. A score for interaction effectiveness for the entire class was computed.
Covered Fall 2021, and Spring 2022.</td><td>What were your findings?
Score range: 1 (unsatisfactory),
2 (marginal),
3 (satisfactory), and
4 (excellent).</td><td>Our department believes we fulfill this Learning Outcome because:
(state evidence in 30 words or less)</td></tr>
<tr><td>5. [Tech Comm:] technical communication skills in written and oral form;</td><td>Direct Measure: Quantitative Assessment Procedure (see below) on CSE 325, and 326.</td><td>
<table>
<tr><th>Course</th><th>Score</th><th>Weight</th><th>Overall</th></tr>
<tr><td>CSE 325 F21</td><td>no data</td><td>3</td><td rowspan="2">4</td></tr>
<tr><td>CSE 326 S22</td><td>4</td><td>3</td></tr>
</table>
</td><td>The overall score is higher than 3.0, our acceptance threshold.</td></tr>
</table>

Adjustment/Improvement
CSE 325: No assessment data was provided regarding outcome #5 on the CSE 325 assessment document. It is unclear whether this is because group assignments were curtailed due to covid, or if the omission was inadvertent. The faculty member who wrote this report is no longer with New Mexico Tech. Department Chair will visit with new CSE 325 instructor(s) to ensure that this SO is assessed in future. CSE 326: See earlier comments about CSE 326.

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

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Score range: 1 (unsatisfactory),
2 (marginal),
3 (satisfactory), and
4 (excellent).</td><td>Our department believes we fulfill this Learning Outcome because:
(state evidence in 30 words or less)</td></tr>
<tr><td>6. [Team:] the capacity to work as part of a group</td><td>Direct Measure: Quantitative Assessment Procedure (see below) on CSE 241, 326, 342, 344, and 423.</td><td>
<table>
<tr><th>Course</th><th>Score</th><th>Weight</th><th>Overall</th></tr>
<tr><td>CSE 241 F21</td><td>3</td><td>2</td><td rowspan="5">3.2</td></tr>
<tr><td>CSE 326 S22</td><td>3.67</td><td>3</td></tr>
<tr><td>CSE 342 S22</td><td>3</td><td>3</td></tr>
<tr><td>CSE 344 F21</td><td>3.2</td><td>3</td></tr>
<tr><td>CSE 423 S22</td><td>3</td><td>3</td></tr>
</table>
</td><td>The overall score is higher than 3.0, our acceptance threshold.</td></tr>
</table>

Adjustment/Improvement
CSE 241: This semester, I gave a pretest for recursion, since I was unsure of what would be retained of concepts learned in the covid year. The test performance showed that the students had not retained much of recursion. Since I only did this towards the end of the semester, I did not have time to remedy this and cover all the materials planned. Specifically, I did not have time to cover recursion and induction proofs over trees, formulae etc. We did cover recursion and induction over numbers and arrays of numbers. I plan to give a pretest earlier in the coming semesters in order to be able to address this. CSE 326: CSE 342: This semester, I included the videos prepared in the previous year as extra resources. For some concepts, flipped classroom style instruction was implemented. I was a little concerned about time management of students (some students may have viewed the availability of videos as a fallback and not learned the material in time). However, in feedback surveys, the students overwhelmingly wanted the video lectures and flipped classroom to continue. CSE 344: • More TAs are needed in the labs to provide personal attention to students. • Last year, students were given problem sets to work on but not all of them worked on them. Some incentive options are needed. • Last year, I wrote “The instructor has tried his utmost to wean students from looking up solutions to problems and encourage them to attempt to think and solve problems. The Associate VPAA has drawn our attention to websites such as chegg.com, which, for a small fee, allow access to the solutions of every problem in the text.

Perhaps reducing the weight of homeworks will help." • The most difficult issues remain a lack of preparation in logic and the large number of students in the class.

CSE 423: see adjustments described at SO #2.

Concluding Comments:

Based on ABET requirements, we continue to use last year's set of program / student outcomes and curricular map.

Overall, the 2021-2022 year was still measurably affected by covid.

This report has been read and accepted by the department faculty on Nov 14, 2022.

All course assessment reports can be supplied on request.

Submitted by: Clinton Jeffery Department Chair: Clinton Jeffery Date: 12/3/2022

Reviewed by Assessment Director/Director Signature: Date: (by 10/01)
Comments:

Reviewed by Faculty Senate Assessment Committee/Committee Chair Signature: Date: (by 11/01)
Comments:

Reviewed by Associate VP of Academic Affairs/AVPAA Signature: Date: (by 11/15)
Comments:

Submitted to Vice President of Academic Affairs/Date: (no later than 9/15)