Quantifying the Comprehensiveness of an Academic Computing Program's Continuous Improvement Plan

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***Abstract*—This Research to Practice Full Paper presents the findings of our research about the comprehensiveness of continuous improvement plans and initiatives at academic computing programs. Continuous improvement (CI) plans consist of 8 components: (1) Administration, (2) Curriculum, (3) Course, (4) Faculty, (5) Research, (6) Academic Advising, (7) Facilities, and (8) Support Staff. To implement a truly comprehensive CI plan, an academic computing program must address all 8 CI components by identifying the types of data used for improving each one. For each component, this data can be produced internally (by the CI component itself) or externally (by other CI components). The degree to which two components exchange CI data determines the quality of their CI integration.**

In this paper, we detail a comprehensive list of data types used for each component's continuous improvement. We also propose a quantifiable model (360-CI) to "measure" the comprehensiveness of an academic computing program's continuous improvement plan or initiative. This model is represented by the Academic Computing Continuous Improvement Scoring Survey (ACCISS). ACCISS uses the list of continuous improvement data types to reveal the ones produced and utilized within an academic computing program. ACCISS also aims at identifying potential new data types that can be added to the comprehensive list. The results of the questionnaire can then be mapped to the 360-CI model to generate a comprehensiveness score out of 360.

The questionnaire tool was administered at a large electrical engineering and computer science program. A high response rate provided us with confidence in the results of the generated score. The paper details the process of the questionnaire implementation, the results (including the comprehensiveness score), and the lessons to be learned when the questionnaire is administered in the future. The results also help this specific program identify areas for improvement in their continuous improvement process.

***Index Terms*—Leadership, Faculty development, Accreditation, Organizational assessment, Multilevel program assessment, Interviews, Qualitative, Doctoral Institution**

I. Introduction

Academic computing programs struggle to maintain a level of quality that distinguishes them among their peers. In this efforts, these programs try to continuously change and improve in order to meet expectations of current and prospective students as well as attract distinguished faculty members. Many of these programs turn to accreditation in order to prove their level of quality. Accreditation agencies require some form of documentation of the continuous improvement (CI) process at these programs. Developing and maintaining a CI plan at an academic computing program has its challenges. Many programs who establish successful CI plans struggle to maintain a consistent level of quality. The CI effort in many of these cases peaks prior to the accreditation cycle and then withers afterwards. Ideally that should not be the case as CI is meant to ”constantly and forever (improve) the system of production and service” [1] (the keyword here being ”constantly”). Another challenge is that despite many programs claiming to have established comprehensive CI plans [2]–[4], they do not truly know how comprehensive these plans are. A comprehensive CI plan is one that addresses all aspects of a program in what can be called a 360° view (henceforth, 360-CI).

The goal of this paper is to show-case a novel method to quantify the comprehensiveness of an academic computing program's CI plan or initiative. It starts by briefly discussing the components of a CI plan that establish comprehensiveness. It then addresses how each of those CI components can be improved by itself and together with the other CI components. We propose a perfect 360-CI model in which all of the components cooperate to achieve comprehensiveness. The model contains a list of data types used in the CI process and their integration among the CI components. This model can be used to score the comprehensiveness of an academic computing program.

To determine whether an academic computing program generates and utilizes all the data types in the model, interviews, workshops, and meetings with staff, faculty, and other stakeholders can be conducted. However, this process is lengthy and costly. Instead, we propose a questionnaire tool named the ”Academic Computing Continuous Improvement Scoring Survey” (ACCISS) as a means of measuring the adherence of an academic computing program to CI comprehensiveness.

The second part of this paper summarizes an application of this tool at a large electrical engineering and computer science program. We talk about how the questionnaire was prepared and customized for the specific academic computing program. It then details the scoring scheme. The implementation of the questionnaire and the response rate are then described. After that we elaborate on what the results mean to the 360-CI model as well as to the program itself where ACCISS has provided a comprehensiveness score. We, then, list some limitations and risks to validity. Finally, we conclude by arguing for our vision in how the 360-CI model and the ACCISS tool can be used to improve the CI cycle at academic computing programs.

II. Background

After a systemic literature review, eight components were identified as being key components to continuous improvement (CI) [5], [6]: Course **(C)** [7], [8], Curriculum **(U)** [9], [10], Faculty **(F)** [10], [11], Administration **(A)** [10], [12], [13], Research **(R)** [10], [14], Academic Advising **(D)** [15], [16], Facilities **(T)** [9], [17], and Support Staff **(S)** [9], [10], [18]. To truly implement a comprehensive CI plan or initiative, an academic computing program must address all CI components. Figure 1 represents the CI components as spokes in a wheel. The wheel will run smoothly the stronger its spokes are built and the tighter they are connected together.

In the literature, two slightly similar systems were found to use 5 components: Curriculum, Faculty, Course, Research, and Support Staff [19], [20]. The focus in these systems was not creating a model of comprehensive CI. They were specific implementations of CI data collection tools for each case study's organization. In case of Colorado State University [20], their "comprehensive CI" involved combining multiple existing reporting systems to generate a single source of assessment information for the university community. The focus of the new consolidated system was student learning (Course & Curriculum CI components), faculty research & scholarship (Research CI component), and faculty services (Support Staff & Faculty CI components). Currin [19], on the other hand, proposed using the capstone project course as a vehicle to collect necessary data required for comprehensive CI and measuring program outcomes. The paper proposed a set of questionnaires be administered during the capstone course that collects data relevant to the 5 CI components listed above. In both cases, however, there was no recognition of the CI process having independent CI components and no systemic way of identifying or studying the data types and exchanges required for each.

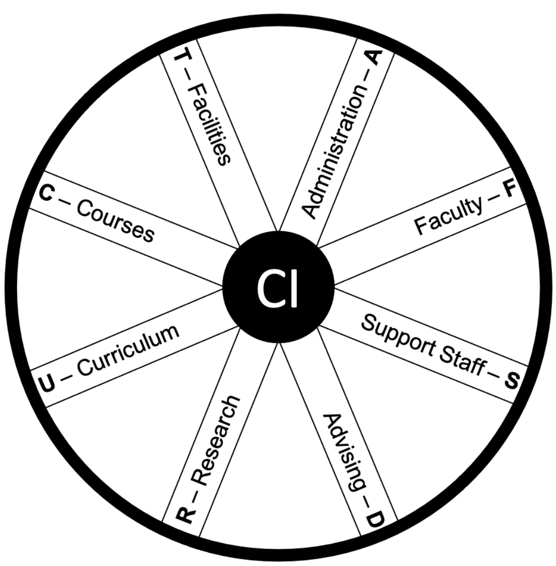

Fig. 1. Eight Components of Comprehensive CI

This research study aimed to empirically identify all the CI components, the data required for improving each component, and the areas of integration between components in an academic computing programs' CI plan. The more data and integration identified, the more comprehensive the CI plan.

The literature review uncovered 40 data types and exchanges among the eight components [5]. A data type is a unique type of data used in the CI process like student grades. A data exchange is a data type being produced by one CI component and utilized by the same or another CI component like student grades produced by Course and utilized by Administration. A data interaction is the collection of data exchanges between two specific CI components like all the data produced by Course and utilized by Faculty.

A follow-up set of interviews in a large electrical engineering and computer science program uncovered 73 data types and exchanges with some overlap with the literature. The result was a list of 104 data exchanges with 79 unique data types over 31 data interactions including two additional data types proposed by the research team [6]. A data interaction is represented by individual cells in Figure 5.

The interviews showed disparity in coverage (or emphasis) of continuous improvement (CI) for certain components compared with others (see Figure 2). The components with strongest CI emphasis were, perhaps predictably, Curriculum, Course, and Faculty, while the Support Staff, Academic Advising, and Facilities components received the least attention [6]. This was in fact consistent with the findings of the literature review [5].

The types of data collected to improve these components were of two general categories: intra-CI-component data types and inter-CI-component data types. Intra-CI-component data types were those produced by a CI component for its own improvement. Inter-CI-component data types were those produced by a CI component and utilized by another CI component. The comprehensiveness of a CI plan depended on the strength of each component by itself as well as on the integration among other components (see Figure 3).

In an ideal world, every CI component would improve itself (scoring 10 out of 10 for its own CI) and contribute to improving every other component (scoring 5 for each component), which would result in a perfect CI plan with a score of 360 (see Figure 4). The ideal scoring matrix in Figure 4 scores a CI component's own cell as a 10, instead of a 5, emphasizing that each CI component must at least work on improving itself. The total for each row (out of 45) indicates how much that row's CI component contributes to the improvement of other CI components, and the total for each column (also out of 45) indicates how much each component is benefiting from other components [21].

However, the currently known data types and exchanges do not cover all cells in the ideal 360-CI scoring matrix. Thus, it was not realistic to score a program using the ideal model. Therefore, an attainable 360-CI scoring matrix utilizing the 104 data types was developed. At this stage, a more realistic score for an academic computing program's CI plan was 195 at most (see Figure 5).

After the 360-CI model and scoring matrices were developed, an Academic Computing Continuous Improvement Scoring Survey (ACCISS) template was created as an online questionnaire to replace interviewing faculty and staff about the CI plan of an academic computing program. The ACCISS questionnaire template contained a question about each thus far identified data type and data exchange. The questions were grouped by the role of the questionnaire participant which was mapped to the relevant CI component. For example, a teaching faculty member was mapped to Faculty (F), and a research faculty member was mapped to Research (R) [21]. ACCISS was also designed to uncover yet unknown data types and data exchanges through open-ended questions.

III. The Academic Computing Continuous Improvement Scoring Survey (ACCISS)

In the previous section, we proposed a 360-CI model and scoring systems, which were used to create the Academic Computing Continuous Improvement Scoring Survey (ACCISS) to quantitatively measure the comprehensiveness of an academic computing program's CI plan. By creating this tool for academic computing programs, we had two main objectives:

- help academic computing programs calculate their 360-CI score, which can highlight areas for improvement, and
- answer the following research questions:
  - **RQ1:** How appropriate is ACCISS in scoring the 360-CI of an academic computing program?
  - **RQ2:** How can the list of attainable 360-CI data types and exchanges be enhanced using ACCISS?
  - **RQ3:** How does the attainable 360-CI scoring matrix change after applying ACCISS?

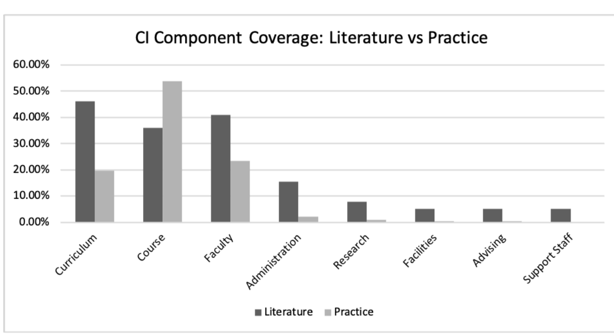

Fig. 2. CI Component Emphasis

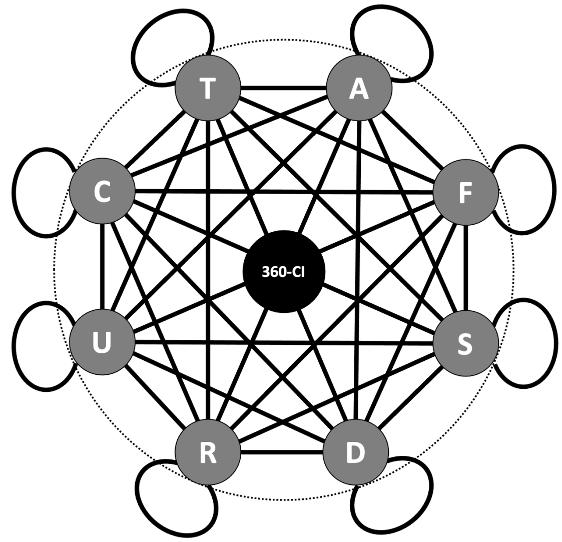

Fig. 3. Ideal 360-CI Model

To start, the data types and exchanges identified in both the literature review and the in-person interviews were used to prepare the ACCISS tool. The questions were grouped by role, where each role represented a node in the 360-CI model (see Figure 3). The language and format of ACCISS was revised multiple times based on input from different groups of users. The major outcome of the informal user studies was a change from radio buttons to a drag-and-drop for roles with a large number of data types to make it easier for participants to complete the questionnaire. In addition, each role group concluded with open-ended questions to facilitate uncovering more unknown data types and data exchanges for that role. A general open-ended question asking: "what else?" was added at the end of the questionnaire for all roles.

After multiple modifications to the tool, the ACCISS template was finalized, and the template can be copied and customized for use within a specific academic computing

	C	T	A	F	S	D	R	U		
C	10	5	5	5	5	5	5	5	45	360
T	5	10	5	5	5	5	5	5	45	
A	5	5	10	5	5	5	5	5	45	
F	5	5	5	10	5	5	5	5	45	
S	5	5	5	5	10	5	5	5	45	
D	5	5	5	5	5	10	5	5	45	
R	5	5	5	5	5	5	10	5	45	
U	5	5	5	5	5	5	5	10	45	
	45	45	45	45	45	45	45	45		
	360									

Fig. 4. Ideal 360-CI Score

	C	T	A	F	S	D	R	U	
C	10	5	5	5		5		5	35
T	5	10		5					20
A	5		10	5	5			5	30
F	5		5	10				5	25
S	5		5		10				20
D						10			10
R		5	5	5			10		25
U	5		5	5		5		10	30
	35	20	35	35	15	20	10	25	195
	195								

Fig. 5. Attainable 360-CI Score

program. For this research study, the template consent, participation incentive, and context for some questions were modified for the participating computing program. The applied ACCISS tool implemented within the participating computing program was ordered as follows:

1) **Consent:** First, there was a consent with details about the questionnaire in order to agree or not agree to continue.
2) **Role Determination Question:** Then, there was an option for consenting participants to select the role that best fit their job within the academic computing program.
3) **Role-Specific Questions:** Next, there were two sets of questions: a matrix of Likert-scale questions and corresponding short-answer questions. The matrix of Likert-scale questions asked whether there was a process to collect each data type relevant to the role selected (represented by the 360-CI model column), and each data type had the following 4-point Likert scale to choose from: Yes, No, Collect-On-My-Own, and Not-Sure. For those data types where Yes or Collect-On-My-Own were selected, text areas were presented for writing a sentence or two about how that piece of information was received and who provided it.
4) **Open-Ended Questions:** After collecting answers about known CI data types, there were 4 short-answer general CI questions. The questions asked participants to elaborate on their own CI, to write any other data types they currently use, to propose other data types that could help in the future, and to list other roles they help improve within the program.
5) **Comments and Suggestions:** Comments and suggestions were solicited in the end, before concluding with a donation page.
6) **Completion Incentive Section:** Lastly, there was an "incentive" section that listed three local charities to select from. A $5 donation was given for each participant's selection.

IV. Methodological Approach

To garner support for recruiting participants, the administration of the program was briefed on the ACCISS tool, and faculty and staff were made aware of the research study in an employee meeting. During the second week after the winter break, faculty, staff, and graduate teaching assistants within the computing program received a recruitment email message to participate in the research study with a link to the ACCISS tool. ACCISS was kept open for about three weeks, during which time faculty, staff, and graduate teaching assistants received two more reminder email messages.

A. Data Collection

When the questionnaire was released, interviewees that already participated (administrators, faculty, and staff members) were told that they did not have to participate again. To calculate an accurate score for the computing program's CI, 15 prior interview answers were converted to questionnaire responses. After the questionnaire was closed, there were a total of 49 participants with four original interviewees who completed the questionnaire again. After the four interview responses were consolidated with their questionnaire responses, the final set of data included 60 participants in this research study (see Table I).

The participants included 2 administrators, 4 academic advisors, 6 course designers, 3 curriculum committee chairs or members, 5 staff members, 20 faculty members, 17 teaching assistants, 2 researchers, and a lab technician (see Table II). The 17 out of 480 teaching assistants represented a participation rate of 3.3%. The remaining 43 out of 151 regular department employees (administrators, faculty, staff, etc.) represented a participation rate of about 28.5%.

TABLE I
Questionnaire Response Rate

	Population	Sample	Rate
Dept. Personnel & Employees	639	60	9.4%
Teaching Assistants	488	17	3.3%
Regular Fulltime Employees	151	43	28.5%

TABLE II
Questionnaire Participant Roles

CI Component	Role	Sample Size
Administration	Administrator	2
Academic Advising	Academic Advisor	4
Course	Course Designer	6
Curriculum	Committee Member	3
Support Staff	Staff	5
Support Staff	TA's	17
Faculty	Faculty Member	20
Research	Researcher	2
Facilities	Lab Owner	1

B. Scoring ACCISS

The ACCISS tool was used to measure the comprehensiveness of a large academic computing program's CI plan. Each Likert question in the "Role-Specific Questions" corresponded to a data type in the 360-CI model (see Table V). Each answer was scored as follows: Yes = 1; No = 0; Collect-On-My-Own = 0.75; and Not-Sure = 0.25. These values were selected to give more weight on collecting data than not being sure.

The score for each cell in the matrix was determined by averaging the responses for each data type, and then, the average score of all data types in that specific cell was multiplied by the cell's factor: 10 for intra-CI-component data types and 5 for inter-CI-component data types (see Figure 4).

For example, the **A→F** cell (A being the row and F being the column) has four data types: A08, A09, A10, and A14 (see Table V). Table III shows the scoring for each data type using the ACCISS responses. The average score of the responses was 0.477.

The average response score from the four data types was then multiplied by the cell factor of 5 for a final score that was almost 2.4 in that cell (see Figure 6). The final score for each cell based on participants' responses is displayed in Figure 6. Based on the 60 ACCISS responses, the 360-CI score of this specific program's CI plan was just below 110.

V. Results and Discussion

In this section, we answer the research questions posed in Section III using the ACCISS scoring and analyzing the open-ended responses. Each of the three research question are answered below.

*A. **RQ1:** How appropriate is ACCISS in scoring the 360-CI of an academic computing program?*

The 360-CI score of 110 indicated that the CI plan of this electrical engineering and computer science program was not as comprehensive as it could be. The Course (C) component had the highest score both vertically and horizontally. Facilities (T) was least improved by others (a score of 0/45), and the component minimally helped to improve other components (a score of only 6.5/45). The only other component contributing less was Academic Advising (D) (4.4/45). Most participants seemed to understand the questions with no trouble which validated how these data types were expressed.

TABLE III
Example Scoring of **A→F** Cell Data Types

Data Type	Yes	No	O*	N⋆	Score
"Multip. Factor"	1	0	0.75	0.25	
A08: Faculty Incentives	3	3	1	1	0.500
A09: Appropriate Task Assignment	4	3	0	1	0.531
A10: Policies & Procedures	1	3	2	2	0.375
A14: Self-Reflection Guidelines	3	3	1	1	0.500
Average Score:					0.477

∗ *O: Collect-On-My-Own*
⋆ *N: Not-Sure*

A single participant wrote "Not Sure" in the short-answer field about collecting data for "Matching of Student Outcomes to Objectives for Courses Design" (C13) and for "Assessment Methods to Evaluate Objectives for Courses Design" (C12). Another participant also indicated in the short-answer field that they were not sure about collecting data for "Results of Hiring Practices" (A02). Two other participants did not understand the question about the "other roles they help to improve." Accordingly, these questions will need to be clarified in the ACCISS questionnaire template.

It is also worth noting that the original list of data types included two data types proposed by the research team: S02, and S03. Those data types were confirmed by participants in this specific implementation of ACCISS. Therefore, those two data types are assumed to be valid.

*B. **RQ2:** How can the list of attainable 360-CI data types and exchanges be enhanced using ACCISS?*

In the open-ended questions, participants' written responses mostly described data types and data exchanges that were already identified. Many responses also identified some new CI data types and exchanges. The new data types are listed in Table IV and marked as new data types. Also, there were proposed data types that were not currently being used but participants proposed, which are indicated in Table IV.

The new data types to add are marked with a "Yes" under the "New to Model" column in Table IV. There was one new data type for each of the Course and the Curriculum components. Participants indicated that they would benefit from **training on course design** (C29) in the Course component and from **training on curriculum design** (U14) in the Curriculum component.

Support Staff participants provided a rich list of data types. They indicated that they would benefit from **articulation of program's goals** (A15) and from understanding **changes to their roles** (A16). They also mentioned that they set their **own**

	C	T	A	F	S	D	R	U	
C	7	0	4.3	3.3	0	4.8	0	3.5	23
T	3.5	0	0	3	0	0	0	0	6.5
A	2.5	0	6	2.4	2.7	0	0	5	19
F	3.5	0	2.5	7	0	0	0	5	18
S	3.5	0	1.3	0	8.3	0	0	0	13
D	0	0	0	0	0	4.4	0	0	4.4
R	0	0	1.3	1.6	0	0	4.2	0	7
U	4	0	5	3	0	4.1	0	3.3	19
	24	0	20	20	11	13	4.2	17	

Total (rows): **109.665**
Total (columns): **109.665**

Fig. 6. Questionnaire Result: 360-CI Score

TABLE IV
DATA TYPES UNCOVERED IN OPEN-ENDED QUESTIONS

CI Comp.	Code	Data Type	New to Model	Proposed
C	C02	Faculty Feedback		
	C11	Student Feedback		
	C29	Course Design Training	Yes	Yes
A	A05	Community Feedback		
	A06	Staff Interviews		
	A11	Co-admin Feedback		
	A12	Admin Internal Feedback		
A→S	**A15**	Articulation of Goals	Yes	Yes
	A16	Changes to Role	Yes	Yes
F	F09	Training		
S	**S05**	Own Goals	Yes	
	S06	Training	Yes	
	S07	Student Demographics	Yes	Yes
	S08	Peer Experience Sharing	Yes	Yes
S→F	**S04**	New Faculty Assistance	Yes	
D	**D05**	Internal Advising Feedback	Yes	
	D06	Career Counseling Training	Yes	Yes
D→C	**D03**	Student Workload*	Yes	Yes
D→A	**D03**	Student Workload*	Yes	Yes
	D04	Advising Workload	Yes	Yes
D→U	**D03**	Student Workload*	Yes	Yes
R	R02	Existing Research		
R→F	R02	Existing Research		
U	U10	Curriculum Updates		
	U14	Curriculum Design Training	Yes	Yes
	∗ Proposed by research team			

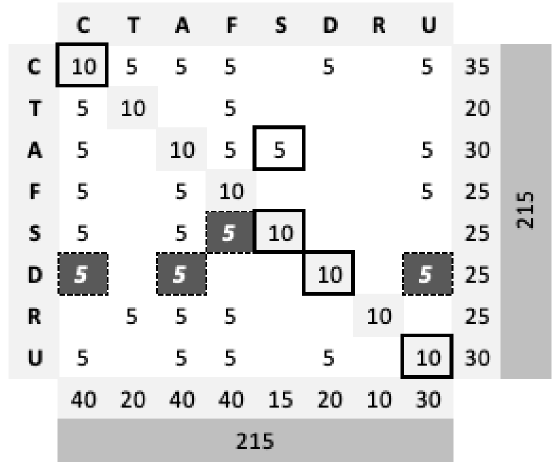

Fig. 7. New Attainable 360-CI Score

goals (S05) and try to meet them. **Training for their job** (S06) was also mentioned as a form of continuous improvement. They proposed that understanding the **student demographics** (S07) would help educate support staff on different needs of different groups within the program. They also proposed that learning about and **sharing of their peers' experiences** (S08) would be beneficial. A suggestion was made to record YouTube videos of their experiences to capture their current challenges and experiences to be shared with others in the future. Support staff also indicated that they provide **new faculty members with assistance and knowledge** (S04) that help bring them up to speed with the program's policies and practices.

Academic Advising participants indicated that they currently provide **internal advising group feedback** (D05). They mentioned that they would benefit from **career counseling training** (D06). They also indicated that if their **own workload** (D04) was provided to the administration consistently, it would help in determining the ratio of students to advisors. The academic advising team also proposed the idea of communicating the **student workload** (D03) to other components (namely: Course, Administration, and Curriculum). Sharing student workload with the course designers (Course component) can help instructors improve course material and assignments. When the student workload is shared with the administrators (Administration component), administrators can better assess the administration processes and set realistic expectations of their students. Student workload can also help curriculum committee members design better curricula that students can complete more effectively.

C. *RQ3: How does the attainable 360-CI scoring matrix change after applying ACCISS?*

Participants identified 12 new unique data types corresponding to 12 new data exchanges over 7 data interactions. Based on a comment by an Academic Advising participant about workload, the research team proposed a 13th data type: Student Workload (D03). This data type corresponds to 3 data exchanges over 3 different data interactions. The total of new data types is 13 contributing to 15 data exchanges over 9 interactions as can be seen in Figure 7. New data interactions are represented by dark cells: **S→F**, **D→C**, **D→A**, and **D→U**. Since all these new exchanges were inter-CI-component exchanges, each added 5 points to the maximum attainable score. The new attainable score is 215, as displayed in the new scoring matrix in the same figure.

Existing interactions with new data exchanges are highlighted with thick borders around their corresponding cells. Those new data exchanges do not change the maximum attainable score. Instead, they change how the score of those cells is calculated.

Based on the participants in this study, the known (or attainable) list of data types and exchanges increased from 104 (identified prior to this specific ACCISS implementation) to now 119 as displayed in Table V. This research study identified 13 new data types that are involved in 15 data exchanges for a comprehensive CI plan. The number of data interactions (active cells) in the attainable 360-CI model is now 35. The ACCISS questionnaire validated many data types and data exchanges, and the open-ended questions identified the new data types and exchanges.

VI. RISKS & LIMITATIONS

Questionnaire studies run a few risks in general. In the case of this ACCISS questionnaire, there was the possibility of the question text format biasing a participant's answer. In order to limit this risk, the questions were revised multiple times with different groups prior to the official implementation. Another risk with this questionnaire was that participants could have provided responses they thought the researchers wanted, rather than truthful answers. To mitigate this risk and help participants feel safe providing their answers, we clearly stated in the consent form that their identities would not be shared.

The roles representing components within the sample were not distributed evenly. For example, the sample contained only two participants for the Administrator component and one for the Facilities component. There were a much larger number of participants in the Faculty and Support Staff components. This could result in emphasizing certain types of CI data types and exchanges and not highlighting others. At the same time, in practice, the number of administrators and lab owners within an academic computing program is much smaller than faculty members and staff. So, despite the uneven distribution of the sample, it was similar to the distribution of roles within the program.

The number of CI data types in ACCISS was very large. Since it was unrealistic to expect every participant to answer all of them, the questionnaire was split into sets based on a participant's role. However, many participants have several roles within an academic computing program. For example, a faculty member can also be a course designer, and the same faculty member could be a curriculum committee member and a researcher. The set of all relevant questions for such faculty members could be prohibitively large. Thus, the questionnaire was designed in a way to limit the number of questions based on the most significant role of the participant. This might have led to some important insights being omitted. Receiving a large number of responses would mitigate this issue.

The time between the administration of the academic computing program announcing the questionnaire and the time it was actually sent out to all potential participants was a few weeks. This might have contributed to a smaller participation than if the questionnaire were released right after the administration announced it. Future implementations should better coordinate the announcement and the distribution. The support of the administration of any academic computing program to such effort is paramount.

VII. Conclusion & Future Work

In this Research-to-Application paper, we started by briefly describing how this project evolved. A systemic literature review was conducted on CI in academic computing programs. This effort uncovered 8 CI components and showed that many comprehensive CI plans are not truly comprehensive. About 40 CI data types with their respective data exchanges were identified in the literature, and this research study another 73 data types with their respective exchanges between components.

These data, as well as the 8 CI components, were analyzed using a perfect 360-CI model and scoring matrix (see Figure 4). In theory, if all data types and exchanges between the 8 CI components were known, an academic computing program could score 360 out of 360 in their CI initiatives. However, the set of known data types and exchanges do not cover all integration points (see Figure V). Based on the 360-CI model, empirical evidence in interviews, and an attainable scoring matrix, a questionnaire tool called the Academic Computing Continuous Improvement Scoring Survey (ACCISS) was developed to help quickly quantify a computing program's CI plan or initiative, while still uncovering new attainable data types and data exchanges.

We deployed the ACCISS questionnaire in a large electrical engineering and computer science program, and the results of the questionnaire validated the original 360-CI model. We validated the recognition of most of the data types as well as uncovered new data types and exchanges. Through this process, the attainable 360-CI score increased, which gets us closer to achieving a perfect 360-CI model. The tool uncovered 15 new data types and exchanges that were either currently being utilized by the participants or being proposed. The attainable score was thus enhanced to be out of 215 (see Figure 7), and the new data types and exchanges were added to the ACCISS questionnaire template.

In the future, the new data types and exchanges proposed by the research team need to be validated. This can be done through further implementations of ACCISS or by more rigorous interviews with various academic computing programs' faculty and staff. Similarly, the new data types identified for existing exchanges (or cells in the scoring matrix) should be validated in future research. In addition, the Support Staff should be split into two categories: academic support staff and administrative support staff. Currently, the 360-CI model or ACCISS questionnaire does not differentiate between the two.

Applying the ACCISS questionnaire at more academic computing programs is necessary to further corroborate the results and enhance the 360-CI model to actually reach an attainable score of 360. Any new such implementation must reflect changes based on the findings of its predecessors. The administration of each of those programs will need to be involved heavily in the process; especially in selecting the appropriate incentive for each program. Many participants in the ACCISS questionnaire summarized in this paper did not select any charitable organization for donation. This indicates that a better effort is needed in understanding what motivates members of a specific academic computing program. Each individual program administration will be better suited in identifying those incentives.

With every new implementation of ACCISS, the attainable 360-CI score will move closer to a perfect score. The ACCISS template of questions needs to change to reflect new knowledge gained from each implementation. This paper presents a repeatable process in which the current attainable 360-CI model can be applied and enhanced. A complete model along with a concisely written set of ACCISS questions (which will be supplied with a link upon acceptance), will help academic computing programs easily quantify their own CI plans. It is a place from which stakeholders of the CI process can start from in evaluating their existing CI efforts.

TABLE V
COMPREHENSIVE LIST OF CI DATA TYPES & EXCHANGES

U – Curriculum CI Data:
- U01: Senior/Exit Surveys
- U02: Employer Surveys
- U03: Internship Reports
- U04: Alumni Surveys
- U05: Accreditation Report
- U06: Comprehensive Exams
- U08: Course Objectives
- U09: Program Recommendations
- U10: Curriculum Details
- U14: Curriculum Design Training ⋆⋆

UF – Curr. CI Data→Faculty CI:
- U07: Required Skills
- U08: Course Objectives
- U13: Teacher Knowledge & Skills

UC – Curr. CI Data→Course CI:
- U08: Course Objectives
- U09: Program Recommendations
- U12: Required Course Changes

UA – Curr. CI Data→Admin. CI:
- U09: Program Recommendations

UD – Curr. CI Data→Advising CI:
- U11: Ground Rules for Advising

F – Faculty CI Data:
- F01: Experience Reflection
- F02: Feedback on Own Teaching
- F03: Self-Appointed Goals
- F05: Improvement Goals
- F06: Annual Reviews
- F09: Training
- F10: Mentorship Feedback

FU – Faculty CI Data→Curr. CI:
- F07: Fac. Feedback on Dept Policies

FC – Faculty CI Data→Course CI:
- F02: Feedback on Own Teaching
- F05: Improvement Goals
- F08: New Course Ideas

FA – Faculty CI Data→Admin. CI:
- F04: Hiring Priorities
- F11: Faculty Feedback

D – Advising CI Data:
- D01: Student Evaluation
- D02: Seniors Feedback & Interviews
- D05: Internal Advising Feedback ∗
- D06: Career Counseling Training ⋆⋆

DC – Advising CI Data→Course CI:
- D03: Student Workload ⋄

DA – Advising CI Data→Admin CI:
- D03: Student Workload ⋄
- D04: Advising Workload ⋆⋆

DU – Advising CI Data→Curr. CI:
- D03: Student Workload ⋄

C – Course CI Data:
- C02: Faculty Feedback
- C08: Course Evaluation Results
- C09: Textbook Quality
- C10: Student Results
- C11: Student Feedback
- C12: Assessment Fit to Objectives
- C13: Student Outcomes to Objectives
- C14: Course Articulation Matrix
- C19: Course Dependencies
- C20: Course Details & Syllabus
- C21: Student Demographics
- C22: Intangible Student Outcomes
- C23: Class Size
- C27: Similar Course Review
- C29: Course Design Training ⋆⋆

CU – Course CI Data→Curr. CI:
- C01: Course Adequacy
- C02: Faculty Feedback
- C03: Course Outcome Redundancy
- C04: Curriculum Articulation Matrix
- C08: Course Evaluation Results
- C10: Student Results
- C11: Student Feedback
- C13: Student Outcomes to Objectives
- C19: Course Dependencies
- C20: Course Details & Syllabus

CF – Course CI Data→Faculty CI:
- C02: Faculty Feedback
- C05: Student Evaluation
- C06: Weekly Student Feedback
- C07: Learn. Outcome Achievement
- C08: Course Evaluation Results
- C11: Student Feedback
- C24: Teacher Adequacy for Course
- C25: New Knowledge for Teachers
- C26: Student Evaluation of Teachers
- C28: Co-Teacher Feedback

CT – Course CI Data→Facilities CI:
- C15: Adequacy of Lab Software
- C16: Special Course Requirements
- C17: Classrooms (A/C, lights…)

CD – Course CI Data→Advising CI:
- C10: Student Results

CA – Course CI Data→Admin. CI:
- C18: Course Accreditation Feedback

T – Facilities CI Data:
- T02: Facility Personnel & Employees Feedback

TF – Facilities CI Data→Faculty CI:
- T01: Delivery Method

TC – Facilities CI Data→Course CI:
- T01: Delivery Method

A – Administration CI Data:
- A02: Hiring Practices
- A03: Industry & Employer Surveys
- A04: Alumni Surveys
- A05: Community Feedback
- A06: Staff Interviews
- A10: Policies & Procedures
- A11: Co-admin Feedback
- A12: Admin Internal Feedback

AU – Admin. CI Data→Curr. CI:
- A01: Curriculum Goals & Outcomes
- A03: Industry & Employer Surveys
- A07: Peer Institution Comparison

AF – Admin. CI Data→Faculty CI:
- A08: Faculty Incentives
- A09: Appropriate Task Assignment
- A10: Policies & Procedures
- A14: Self-Reflection Guidelines

AC – Admin. CI Data→Course CI:
- A01: Curriculum Goals & Outcomes
- A07: Peer Institution Comparison
- A10: Policies & Procedures
- A13: End-of-Course Evaluation

AS – Admin. CI Data→Supp. Staff CI:
- A09: Appropriate Task Assignment
- A15: Articulation of Goals ⋆⋆
- A16: Changes to Role ⋆⋆

R – Research CI Data:
- R02: Existing Research
- R03: Community Feedback
- R04: Practice & Writing Papers

RF – Research CI Data→Faculty CI:
- R06: Fellowship Appl. Feedback

RA – Research CI Data→Admin. CI:
- R05: Findings to Admin

RT – Research CI Data→Facilities CI:
- R01: Standards of Lab Equipment

S – Support Staff CI Data:
- S02: Staff Feedback
- S03: Staff Performance Review
- S05: Own Goals ∗
- S06: Training ∗
- S07: Student Demographics ⋆⋆
- S08: Peer Experience Sharing ⋆⋆

SC – Supp. Staff CI Data→Course CI:
- S01: Feedback on Course

SA – Supp. Staff CI Data→Admin. CI:
- S02: Staff Feedback

SF – Supp. Staff CI Data→Faculty CI:
- S04: New Fac. Knowledge Assist. ∗

∗ *Identified in Questionnaire*
⋆ *Not Currently Utilized; Proposed by Participant*
⋄ *Proposed by research team*

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